Flow Calculation
User Manual

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1. INTRODUCTION

1.1. Scope and Purpose

The scope of this document is to provide user information about the flow calculation hardware and software setup for its proper functioning.

This document also covers test data as per Albert Energy and Utility Board (AEUB) Directive 14 document.

1.2. Basis of Design

The documents listed below are common design basis for this specification. Documents occasionally referred by the individual section will be directly listed within the section. Cross references of other deliverable documents will be referred with the document.

#	Document Title	Source
1	American Gas Association Report No. 3	AGA
2	American Gas Association Report No. 8	AGA
3	American Gas Association Report No. 5	AGA
4	American Gas Association Report No. 7	AGA
5	GPA2172-96 Calculation for gross heating value	GPA
6	API Manual Of Petroleum Measurement Standards. Chap 21, Section 1	API
7	Wikipedia. The Free Encyclopaedia	Web

1.3. Definition, Abbreviation and Terminology

1.3.1. Definition

Item	Description
AEUB	Albert Energy and Utility Board
API	American Petroleum Institute
Applet	Programs written in the Java programming language that are included in a web page
Crossover Cable	This is a type of cable wiring schema where the cable will be used to connect the controller to a DTE (for example like a laptop)
CSV format	A format where each record is a single line and each field in the record is indicated by a comma.
DB9	RS232 serial communication connector which uses 9 pin (male or female).
DCE (Data Circuit-terminating Equipment)	A device that sits between the data terminal equipment (DTE) and a data transmission circuit (for example like a router or a hub).
DTE (Data Terminal Equipment)	An end instrument that converts user information into signals or reconverts received signals (for example like a computer or RTU).
Floating point	32 bit real number
Gateway	Node (a router) on a TCP/IP network that serves as an access point to another network.
Hyperlink	Location within the web page where the document can be followed
Java	A type of software programming language that allows virtual machine program development
Kernel	Central component of operating system
Meter Run	Flow calculation using a particular algorithm with user defined input
Modbus	Communications protocol (serial and TCP) published by Modicon in 1979 for use with its programmable logic controllers (PLCs)
Operating System	Set of programs that manage computer hardware resources and provide common services for application software.
Recommended Standard 232 (RS-232)	Traditional name for a series of standards for serial binary single-ended data and control signals connecting between a DTE (Data Terminal Equipment) and a DCE (Data Circuit-terminating Equipment).
Recommended Standard 485 (RS-485)	A standard that defines the electrical characteristic of driver and receiver for use in balance digital multipoint systems.
Service set	An SSID is the name of a wireless local area network (WLAN).

identification (SSID)	All wireless devices on a WLAN must employ the same SSID in order to communicate with each other.
Straight Though Cable	This is a type of cable wiring schema where the cable will be used to connect the controller to a DCE (for example like a hub or a switch)
Virtual Machine (Java)	A "completely isolated guest operating system installation within a normal host operating system".
Unix Time	System for describing instances in time, defined as the number of seconds that have elapsed since midnight Coordinated Universal Time (UTC), 1 January 1970, not counting leap seconds.
WEP Key	It is a security algorithm for IEEE 802.11 wireless networks that is adopted by the XynetSCADA for wireless access
Wi-Fi	A mechanism for wirelessly connecting electronic devices
Wi-Fi Ad hoc Connection	Ad hoc connection mode is a method of wireless card in the XynetSCADA to directly communicate with any Wi-Fi enabled devices such as laptop and smart phone

1.3.2. Abbreviation

AGA	American Gas Association
CSV	Comma-Separated Values
DCE	Data Circuit-terminating Equipment
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name Server
DTE	Data Terminal Equipment
EFM	Electronic Flow Measurement
EGM	Electronic Gas Measurement
HMI	Human Machine Interface
HTTP	Hypertext Transfer Protocol
IP	Internet Protocol
MAC	Media Access Control
OS	Operating System
PLC	Programmable Logic Controller
RAM	Random Access Memory
RS232	Recommended Standard 232
RTU	Remote Terminal Unit
RTD	Resistance Temperature Detector
SSH	Secure Shell
SSID	Service Set Identification
TCP	Transmission Control Protocol
URL	Uniform Resource Locator
USB	Universal Bus Serial
WEP	Wired Equivalent Privacy
WLAN	Wireless Local Area Network

2. OVERVIEW

These are notes relating to the program.

- All calculations done in imperial. If input and/or output values are required in metric, conversion must be done in using the web interface or Modbus communication.

- Differential pressure must be greater than or equal to differential cut-off pressure before calculation can be resumed.

- For the equation to calculate accurate flow values, the input values must fall within the specified ranges (see Section 4.0 of this documentation).

- AGA 3, 8 and 7 has been tested as per Alberta Energy and Utility Board (AEUB) test cases. The flowrate, coefficient of discharge (Cd), expansion factor base on upstream static pressure (Y1), expansion factor base on downstream static pressure (Y2), velocity of approach factor (Ev) and compressibility (Z) falls with the specified percentage of tolerance.

- AGA 8 Gross Calculation has been tested as per AGA Report Number 8 test cases.

3. HARDWARE AND SOFTWARE REQUIREMENTS

Here are the hardware and software requirements to run this controller.

- Hardware
  - Ethernet cable
    - If the controller is going through a DCE (such as hub, industrial switch, Ethernet radio), a straight thought Ethernet cable is required.
    - If the controller is going through a DTC (laptop, server, computer), a cross-over Ethernet cable is required.
  - Serial cable
    - If the controller is going through a DCE (such as hub, industrial switch, Ethernet radio), a straight thought serial cable is required.
    - If the controller is going through a DTC (laptop, server, computer), a cross-over serial cable is required.
  - Power supply 6 to 15 VDC
- Software
  - Web browser
    - Microsoft Internet Explorer 7.0 or greater
    - Mozilla Firefox 7.0
    - Note that Java applet security setup on the browser must be set to allow execution of Java applet

4. CONTROLLER SPECIFICATION

The table below shows the system specification.

Processor	ARM920T
CPU Speed	400MHz
Solid State Drive	512MB
SDRAM	64MB
USB	6 USB ports
Ethernet	10/100 BaseT
Power Input	6 to 15 VDC
Power Consumption	1.2 watt with Ethernet cable 2.5 watt max per additional USB device
OS	Linux Debian

These specifications are available in the web interface.

```
http://<IP ADDRESS>/cg-bin/sc/system-status.sh
```

"<IP ADDRESS>" is the IP address of the controller.

5. COMMUNICATIONS

There are five (5) basic way to communicate with the controller and they are as shown in diagram below.

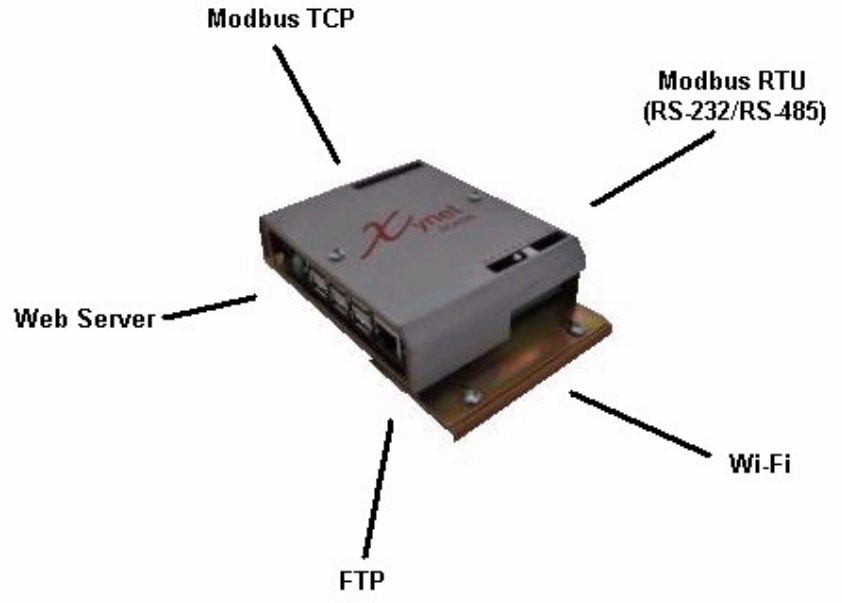


Figure 5.0A, Communications and Services

5.1. Modbus TCP

Modbus TCP protocol can be used to communicate with the controller either via the Ethernet Port or via the Wi-Fi that is available on the controller.

It is a Master Modbus when acquiring data from the RTU, PLC or MVS transmitters for the purpose of flow calculations.

If a HMI is required to be connected to the controller, it will be a Modbus Slave. The complete range of Modbus Slave registers are provided in Appendix B.

5.2. Modbus RTU (RS-232/RS-485)

The controller has six RS 232 or RS-485 communication ports. The configuration of the serial port type will depend on the initial setup of the controller.

These serial ports are used for Modbus RTU communication. It has a full spectrum of serial baud rate and all serial communication is parameters are available for the user to configure.

Like the Modbus TCP that is available on the controller, it is a Master Modbus when acquiring data from the RTU, PLC or MVS transmitters for the purpose of flow calculations. And it performs like a Modbus RTU if a data acquisition software is required to be connected to this controller, like the HMI.

5.3. Wi-Fi Connection

The controller has one Wi-Fi connection which is able to host a Modbus Master function (to acquire flow calculations parameter from RTU, PLC or MVS transmitters for the purpose of flow calculations). Simultaneously, it can perform a function of a gateway to allow user to configure the controller system setup and flow calculation parameters.

5.4. FTP Daemon

An FTP server runs on this controller, hence the user can access all reports and events logs via this web service.

5.5. Web Server (HTTP Daemon)

A light-weight web server is running on this controller which allows the user to access System Configuration and Flow Parameter webpages. Details of these screens are available in the next few sections.

6. WEB INTERFACE

All configuration and setup for the controller and flow parameters can be done using a web browser. The controller has 2 types of web interfaces; System Configuration and Flow Calculation Configuration. The bullet points below shows how to access each of the web interfaces.

- Flow Calculation Configuration Web Interface

  `http://<IP ADDRESS>`
  OR
  `http://<IP ADDRESS>/fc`

- System Configuration Web Interface

  `http://<IP ADDRESS>/sc`

The preferred browser is Microsoft Internet Explorer 8.0

The next few sub section highlights what data is available in each of these web interfaces.

6.1. System Configuration

These web pages allows user to setup and configure all properties and parameters pertaining to the Kernel and hardware. The section below highlights each of the functions in the System Configuration web interface.

6.1.1. Status Tab

The Status Tab shows a read-only version of an overview of the complete system configuration and status.
Generally, all tabs are sub divided into further sub tabs. For the Status Tabs, the following are the sub tabs.

- System
  - Its displays overall hardware information such as type of processor, kernel OS version, MAC Address, on-board user file system and RAM memory space.
- Network
  - Network information is available in this page.
    - Network IP address
    - Network masking
    - Gateway
    - Network mode (DHCP or static IP)
    - Mac address

- Information available in this section is read-only

- Processes
  - This page shows current running processes in the controller, which can come in handy when debugging the controller.
  - In this page and option is available to spawn or stop the process in the controller.
  - Note that the flow computer core program must be shown in this list in order for the flow calculation to be done. The process name are as follows
    - uC.exe
    - uCIPC.exe
  - There must be eleven “uC.exe” processes and two “uCIPC.exe” process for the flow calculation to run properly.
- USB
  - The controller has a total of six USB ports, and the utilisation of each of the USB port and the driver is listed in this page.

Screenshot of each sub tabs are as shown below.

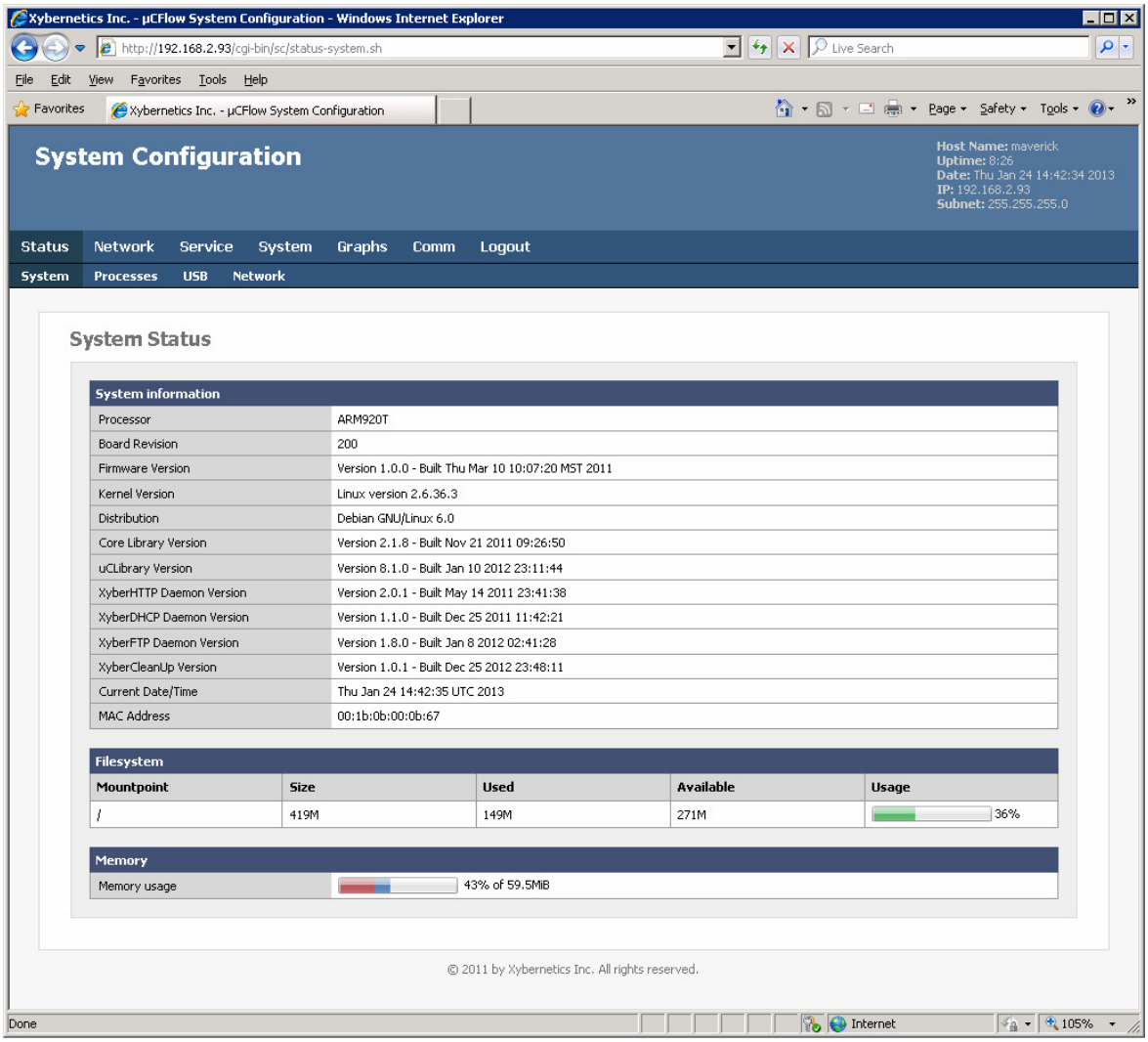

Xybernetics Inc. - µCFlow System Configuration - Windows Internet Explorer
http://192.168.2.93/cgi-bin/sc/status-system.sh
File Edit View Favorites Tools Help
Favorites
Xybernetics Inc. - µCFlow System Configuration
Page Safety Tools
System Configuration
Host Name: maverick
Uptime: 8:26
Date: Thu Jan 24 14:42:34 2013
IP: 192.168.2.93
Subnet: 255.255.255.0
Status Network Service System Graphs Comm Logout
System Processes USB Network
System Status
System information
Processor ARM920T
Board Revision 200
Firmware Version Version 1.0.0 - Built Thu Mar 10 10:07:20 MST 2011
Kernel Version Linux version 2.6.36.3
Distribution Debian GNU/Linux 6.0
Core Library Version Version 2.1.8 - Built Nov 21 2011 09:26:50
uCLibrary Version Version 8.1.0 - Built Jan 10 2012 23:11:44
XyberHTTP Daemon Version Version 2.0.1 - Built May 14 2011 23:41:38
XyberDHCP Daemon Version Version 1.1.0 - Built Dec 25 2011 11:42:21
XyberFTP Daemon Version Version 1.8.0 - Built Jan 8 2012 02:41:28
XyberCleanUp Version Version 1.0.1 - Built Dec 25 2012 23:48:11
Current Date/Time Thu Jan 24 14:42:35 UTC 2013
MAC Address 00:1b:0b:00:0b:67
Filesystem
Mountpoint Size Used Available Usage
/ 419M 149M 271M 36%
Memory
Memory usage 43% of 59.5MiB
© 2011 by Xybernetics Inc. All rights reserved.
Done
Internet
105%

Figure 6.1.1A, Status Tab - System Status

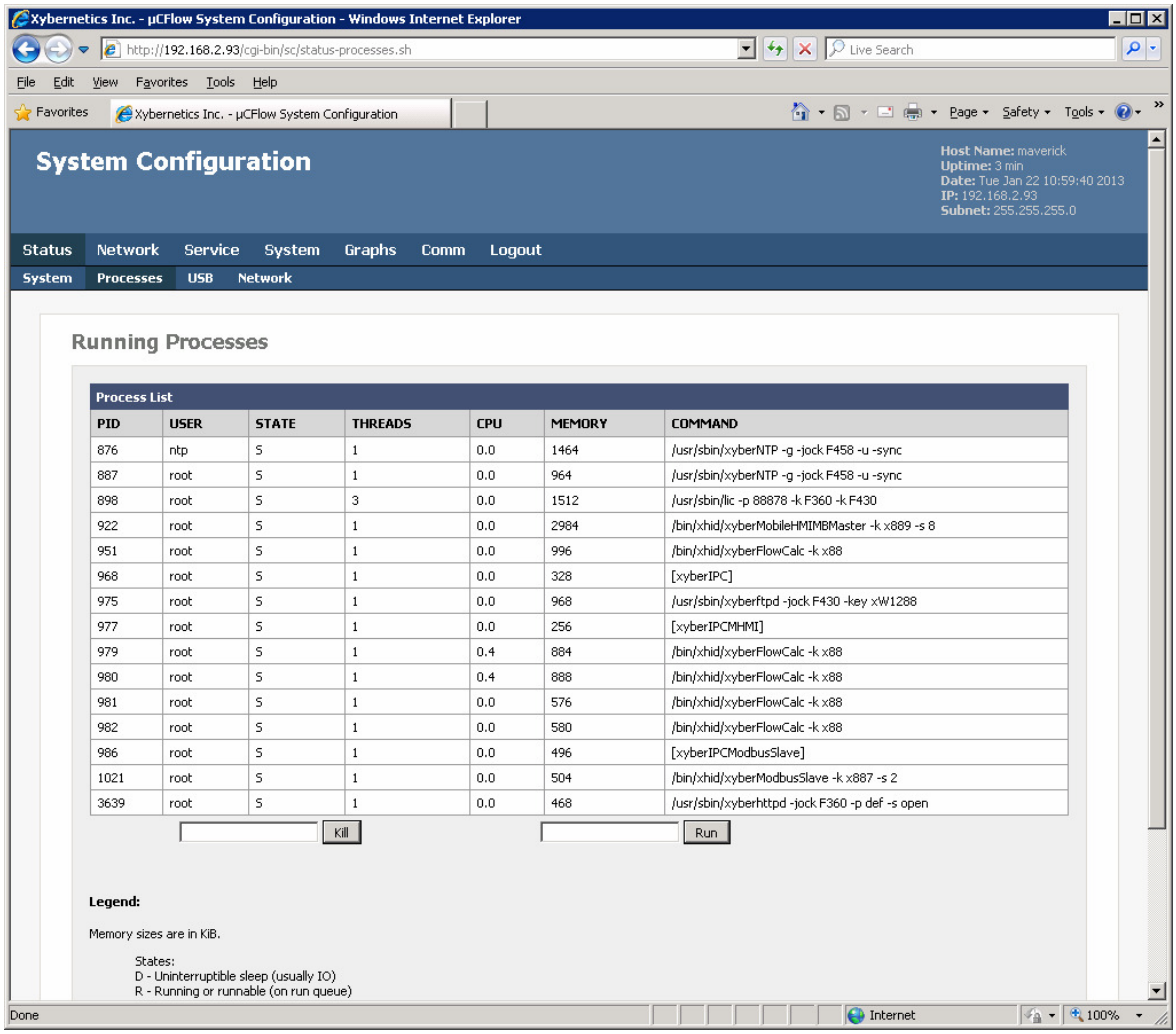
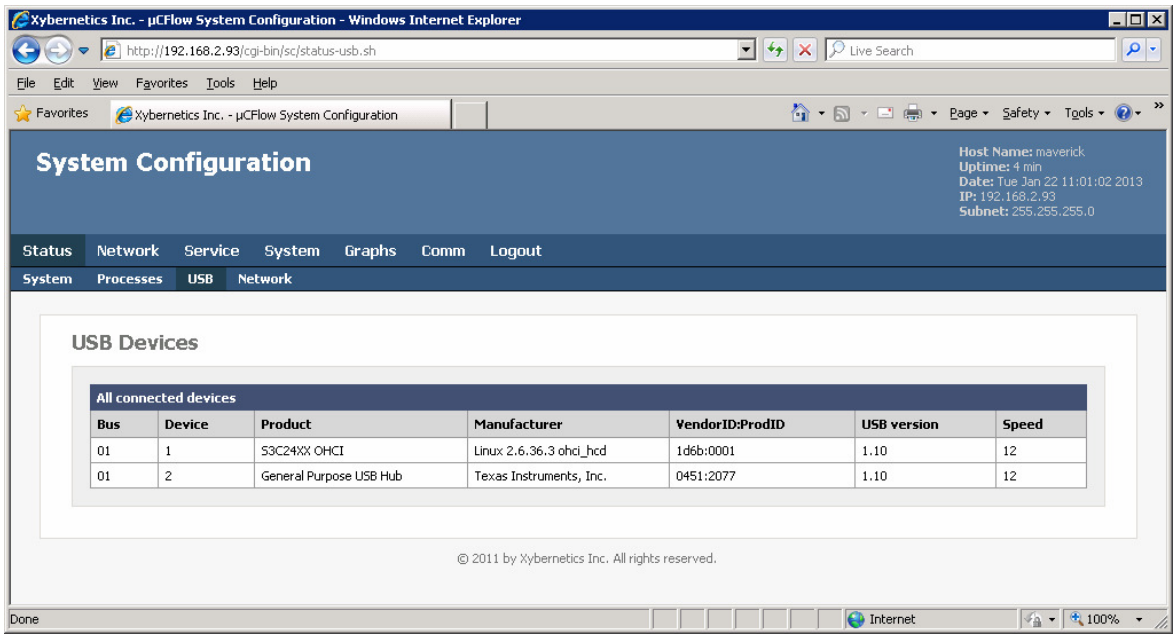

Xybernetics Inc. - µCFlow System Configuration - Windows Internet Explorer
http://192.168.2.93/cgi-bin/sc/status-processes.sh
File Edit View Favorites Tools Help
Xybernetics Inc. - µCFlow System Configuration
System Configuration
Host Name: maverick
Uptime: 3 min
Date: Tue Jan 22 10:59:40 2013
IP: 192.168.2.93
Subnet: 255.255.255.0
Status Network Service System Graphs Comm Logout
System Processes USB Network
Running Processes
Process List
PID USER STATE THREADS CPU MEMORY COMMAND
876 ntp S 1 0.0 1464 /usr/sbin/xyberNTP -g -jock F458 -u -sync
887 root S 1 0.0 964 /usr/sbin/xyberNTP -g -jock F458 -u -sync
898 root S 3 0.0 1512 /usr/sbin/lic -p 88878 -k F360 -k F430
922 root S 1 0.0 2984 /bin/xhid/xyberMobileHMIMBMaster -k x889 -s 8
951 root S 1 0.0 996 /bin/xhid/xyberFlowCalc -k x88
968 root S 1 0.0 328 [xyberIPC]
975 root S 1 0.0 968 /usr/sbin/xyberftpd -jock F430 -key xW1288
977 root S 1 0.0 256 [xyberIPCMHMI]
979 root S 1 0.4 884 /bin/xhid/xyberFlowCalc -k x88
980 root S 1 0.4 888 /bin/xhid/xyberFlowCalc -k x88
981 root S 1 0.0 576 /bin/xhid/xyberFlowCalc -k x88
982 root S 1 0.0 580 /bin/xhid/xyberFlowCalc -k x88
986 root S 1 0.0 496 [xyberIPCModbusSlave]
1021 root S 1 0.0 504 /bin/xhid/xyberModbusSlave -k x887 -s 2
3639 root S 1 0.0 468 /usr/sbin/xyberhttpd -jock F360 -p def -s open
Kill
Run
Legend:
Memory sizes are in KiB.
States:
D - Uninterruptible sleep (usually IO)
R - Running or runnable (on run queue)
Done
Internet
100%

Figure 6.1.1B, Status Tab – Running Process


Xybernetics Inc. - µCFlow System Configuration - Windows Internet Explorer
http://192.168.2.93/cgi-bin/sc/status-usb.sh
File Edit View Favorites Tools Help
Xybernetics Inc. - µCFlow System Configuration
System Configuration
Host Name: maverick
Uptime: 4 min
Date: Tue Jan 22 11:01:02 2013
IP: 192.168.2.93
Subnet: 255.255.255.0
Status Network Service System Graphs Comm Logout
System Processes USB Network
USB Devices
All connected devices
Bus | Device | Product | Manufacturer | VendorID:ProdID | USB version | Speed
01 | 1 | S3C24XX OHCI | Linux 2.6.36.3 ohci_hcd | 1d6b:0001 | 1.10 | 12
01 | 2 | General Purpose USB Hub | Texas Instruments, Inc. | 0451:2077 | 1.10 | 12
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Done
Internet
100%

Figure 6.1.1C, Status Tab – USB Device

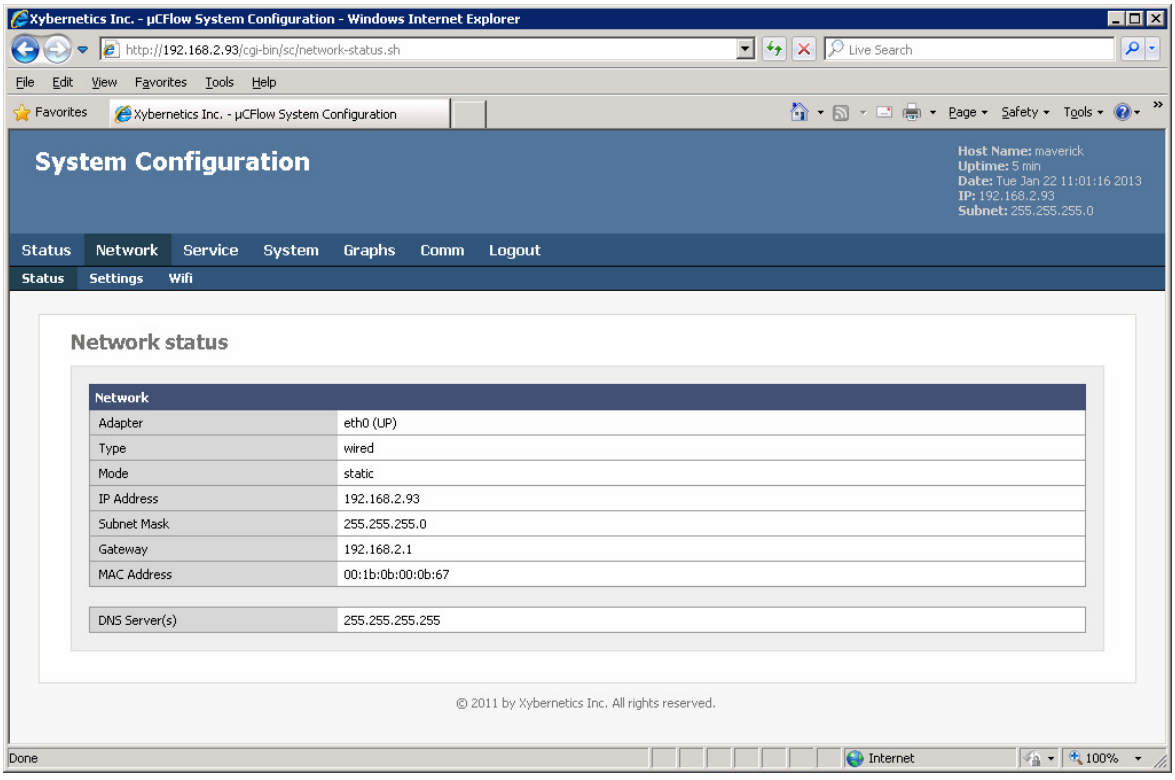

Figure 6.1.1D, Status Tab – Network Status

6.1.2. Network Tab

The Network Tab displays and allows user to configure network parameters. The sub items under this tab are as listed below.

- Status
  - This page displays read-only information about the network parameters
- Settings
  - This page allows user to configure the network parameters as listed below
    - Network Mode (DHCP or static)
    - IP address
    - Network masking
    - Network gateway
    - DNS mode
    - Primary and secondary DNS address
    - SSH Server status
- Wi-Fi Ad hoc Connection
  - This page allows user to configure connection to the controller via wireless connection (Ad Hoc connection).
  - User can change the SSID, the WEP key and the IP address of the wireless card on the controller.
  - WEP key must be a hex number of 9 to 10 character long
  - The “Reset Wi-Fi Card” button restarts the wireless connection and its associated applications. Hence, it is recommended to click on it when the wireless card is connected when the controller is already powered up. If the “Save Changes” button is click, it also emulates the “Reset Wi-Fi Card” button, therefore it is not necessary to click on the reset button when “Save Changes” button is clicked on after the changes are made.

Screenshot of each sub tabs are as shown below.

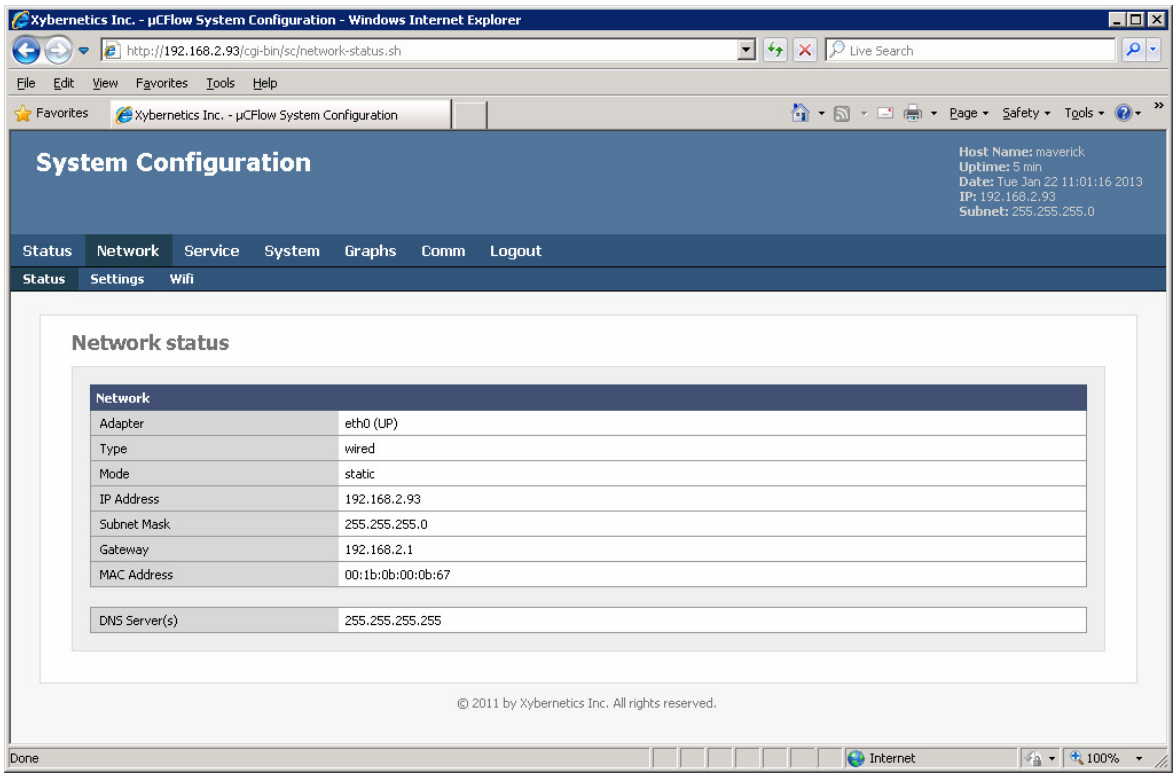

Figure 6.1.2A, Network Tab - Status

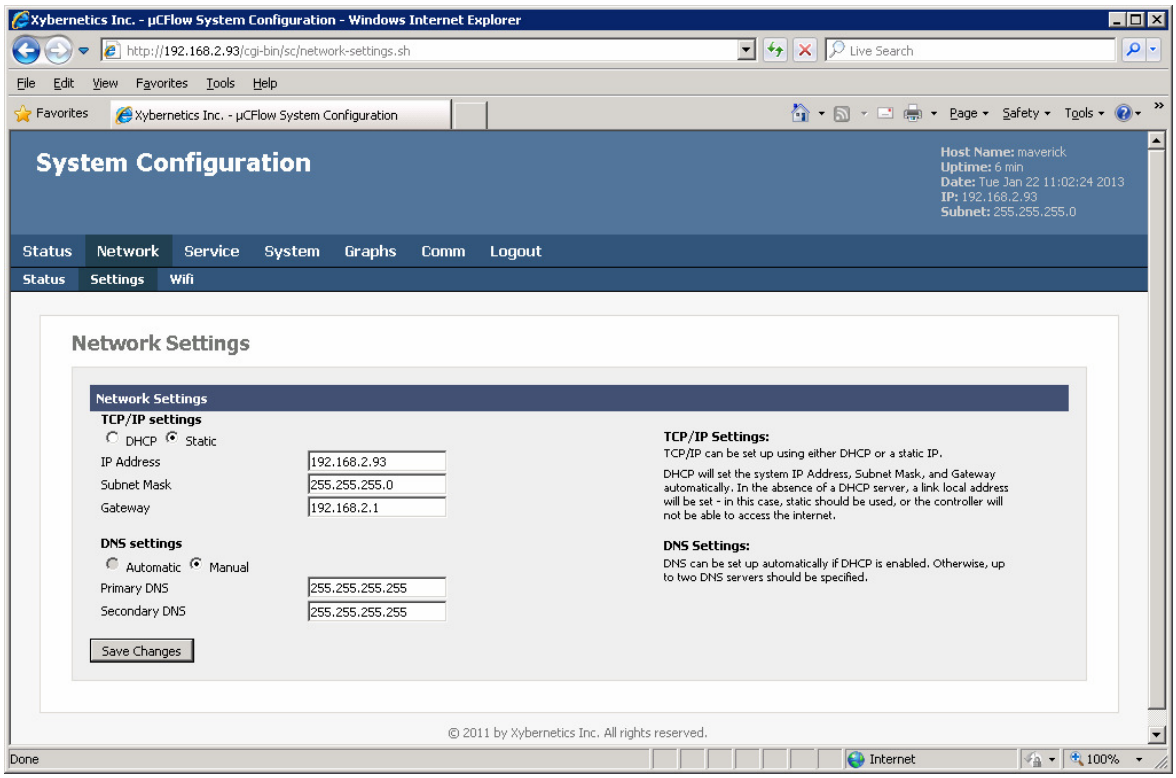
Xybernetics Inc. - µCFlow System Configuration - Windows Internet Explorer
http://192.168.2.93/cgi-bin/sc/network-settings.sh
File Edit View Favorites Tools Help
Favorites
Xybernetics Inc. - µCFlow System Configuration
Page Safety Tools
System Configuration
Host Name: maverick
Uptime: 6 min
Date: Tue Jan 22 11:02:24 2013
IP: 192.168.2.93
Subnet: 255.255.255.0
Status Network Service System Graphs Comm Logout
Status Settings Wifi
Network Settings
Network Settings
TCP/IP settings
DHCP Static
IP Address 192.168.2.93
Subnet Mask 255.255.255.0
Gateway 192.168.2.1
DNS settings
Automatic Manual
Primary DNS 255.255.255.255
Secondary DNS 255.255.255.255
Save Changes
TCP/IP Settings:
TCP/IP can be set up using either DHCP or a static IP.
DHCP will set the system IP Address, Subnet Mask, and Gateway automatically. In the absence of a DHCP server, a link local address will be set - in this case, static should be used, or the controller will not be able to access the internet.
DNS Settings:
DNS can be set up automatically if DHCP is enabled. Otherwise, up to two DNS servers should be specified.
© 2011 by Xybernetics Inc. All rights reserved.
Done
Internet
100%

Figure 6.1.2B, Network Tab - Status

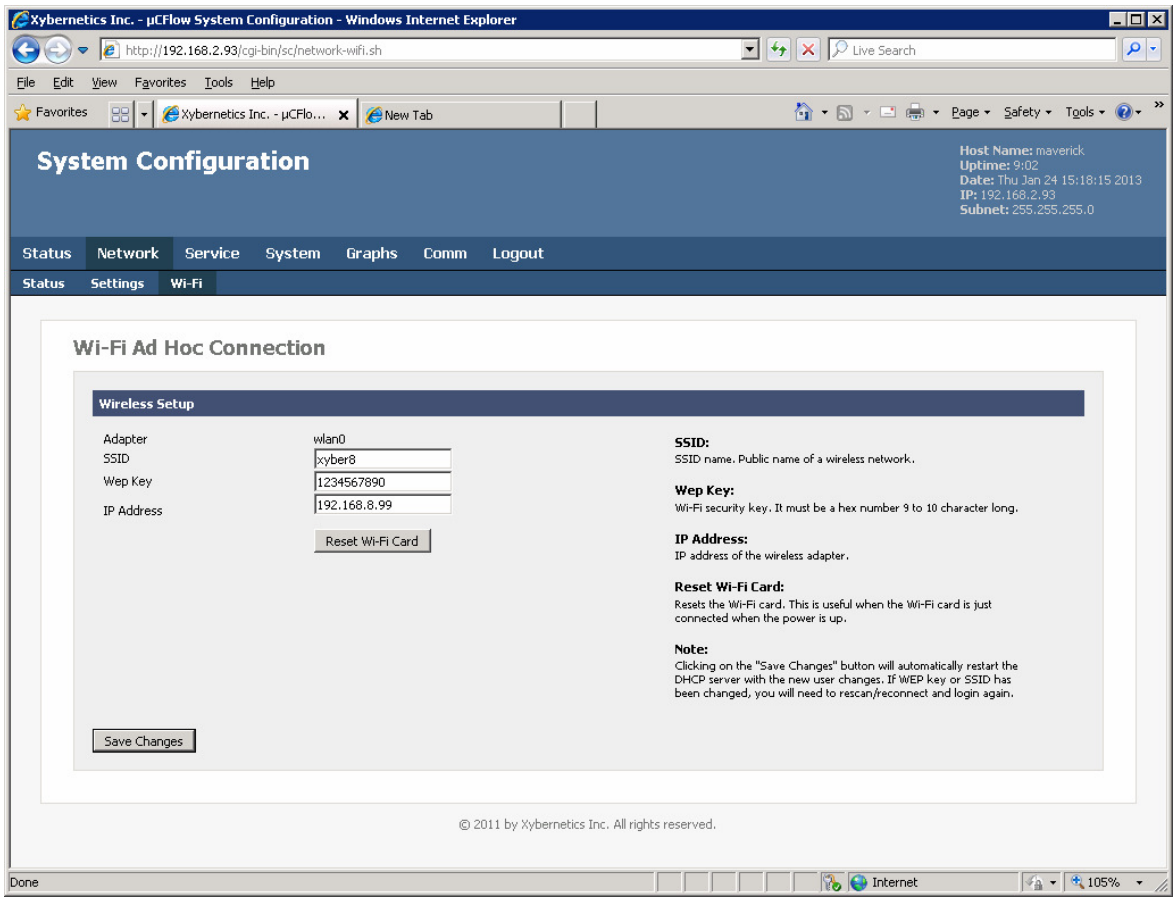
Xybernetics Inc. - µCFlow System Configuration - Windows Internet Explorer
http://192.168.2.93/cgi-bin/sc/network-wifi.sh
File Edit View Favorites Tools Help
Favorites
Xybernetics Inc. - µCFlo...
New Tab
Page Safety Tools
System Configuration
Host Name: maverick
Uptime: 9:02
Date: Thu Jan 24 15:18:15 2013
IP: 192.168.2.93
Subnet: 255.255.255.0
Status Network Service System Graphs Comm Logout
Status Settings Wi-Fi
Wi-Fi Ad Hoc Connection
Wireless Setup
Adapter wlan0
SSID xyber8
Wep Key 1234567890
IP Address 192.168.8.99
Reset Wi-Fi Card
SSID:
SSID name. Public name of a wireless network.
Wep Key:
Wi-Fi security key. It must be a hex number 9 to 10 character long.
IP Address:
IP address of the wireless adapter.
Reset Wi-Fi Card:
Resets the Wi-Fi card. This is useful when the Wi-Fi card is just connected when the power is up.
Note:
Clicking on the "Save Changes" button will automatically restart the DHCP server with the new user changes. If WEP key or SSID has been changed, you will need to rescan/reconnect and login again.
Save Changes
© 2011 by Xybernetics Inc. All rights reserved.
Done
Internet
105%

Figure 6.1.2C, Network Tab - Wireless

6.1.3. Service Tab

The Service Tab displays and allows user to configure web service daemon parameters. The following parameters can be configured for the following web services

- Web Server
  - Shows current running status of the server
  - The default port number is 5001. User is able to change this port number.
- DHCP Service
  - Shows current running status of the server
  - The port number is fixed at 68.
- FTP Server
  - Shows current running status of the server
  - The port number is fixed at 20.
- Clean Up Service
  - Clean Up service deletes all files that are older than user specified days.
  - This service is an essential task as it ensures that there is sufficient capacity to store future reports, log files and execute all the background application smoothly.
  - Clean Up service runs every day at the user specified time. By default the Clean Up service is execute every day at 2359hrs. That is to say, this service does not run all the time in the controller. It runs only when the user define time has expired every day.
  - The Report section of this page also allows user to specify the number of days a particular group of report are kept in the controller.

- Maximum allowed number of days is 2920 days (8years).

Screenshot of the service tab is as shown below.

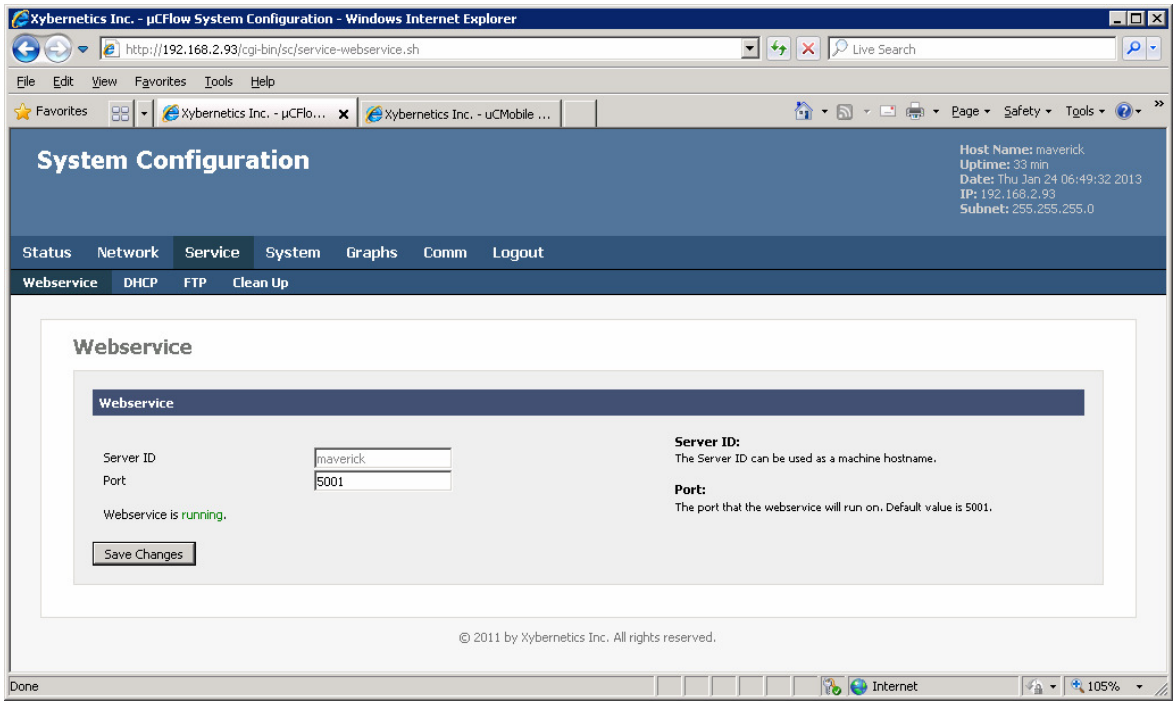

Figure 6.1.3A, Service Tab – Web Server

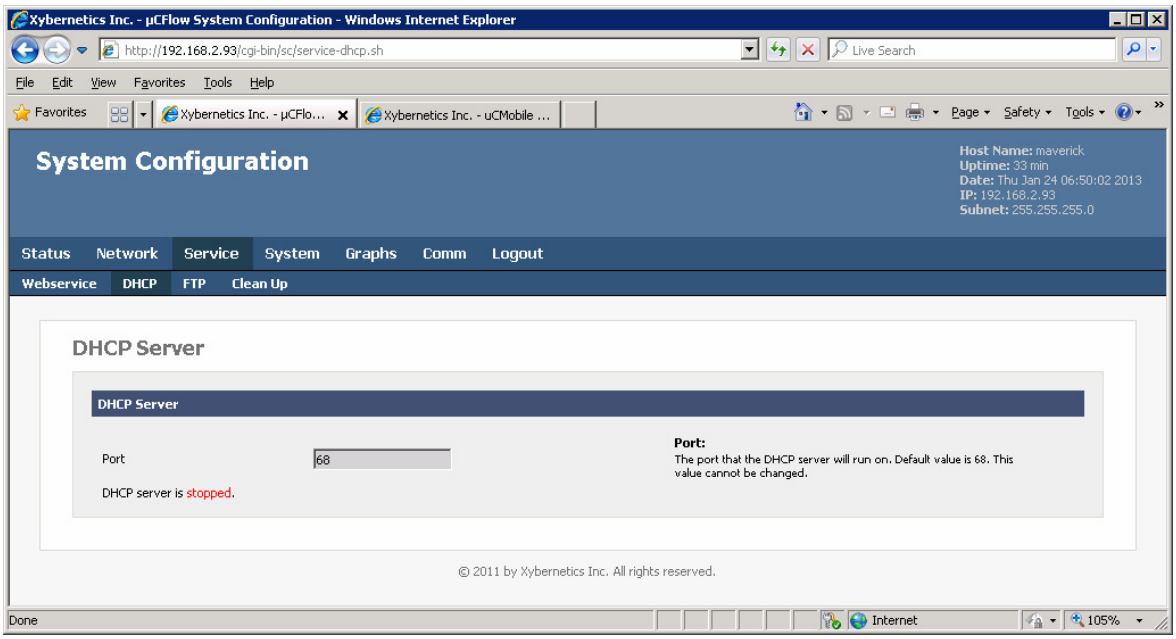
Xybernetics Inc. - µCFlow System Configuration - Windows Internet Explorer
http://192.168.2.93/cgi-bin/sc/service-dhcp.sh
System Configuration
Host Name: maverick
Uptime: 33 min
Date: Thu Jan 24 06:50:02 2013
IP: 192.168.2.93
Subnet: 255.255.255.0
Status Network Service System Graphs Comm Logout
Webservice DHCP FTP Clean Up
DHCP Server
Port
68
DHCP server is stopped.
Port:
The port that the DHCP server will run on. Default value is 68. This value cannot be changed.
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Figure 6.1.3B, Service Tab – DHCP Service

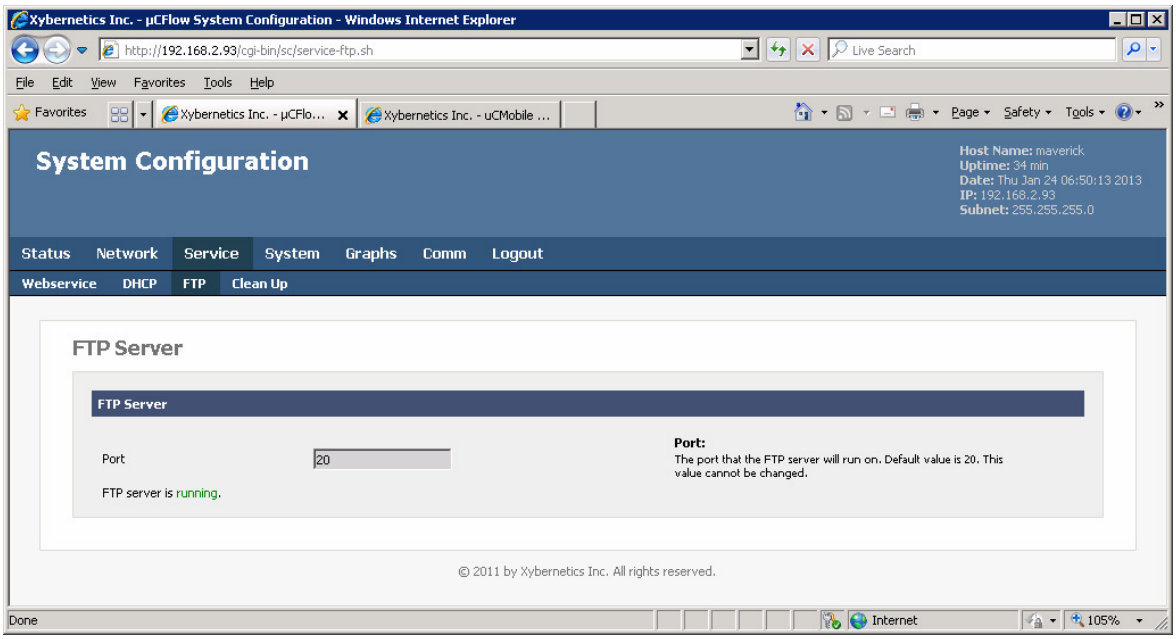
Xybernetics Inc. - µCFlow System Configuration - Windows Internet Explorer
http://192.168.2.93/cgi-bin/sc/service-ftp.sh
System Configuration
Host Name: maverick
Uptime: 34 min
Date: Thu Jan 24 06:50:13 2013
IP: 192.168.2.93
Subnet: 255.255.255.0
Status Network Service System Graphs Comm Logout
Webservice DHCP FTP Clean Up
FTP Server
FTP Server
Port
20
FTP server is running.
Port:
The port that the FTP server will run on. Default value is 20. This value cannot be changed.
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Figure 6.1.3C, Service Tab – FTP Server

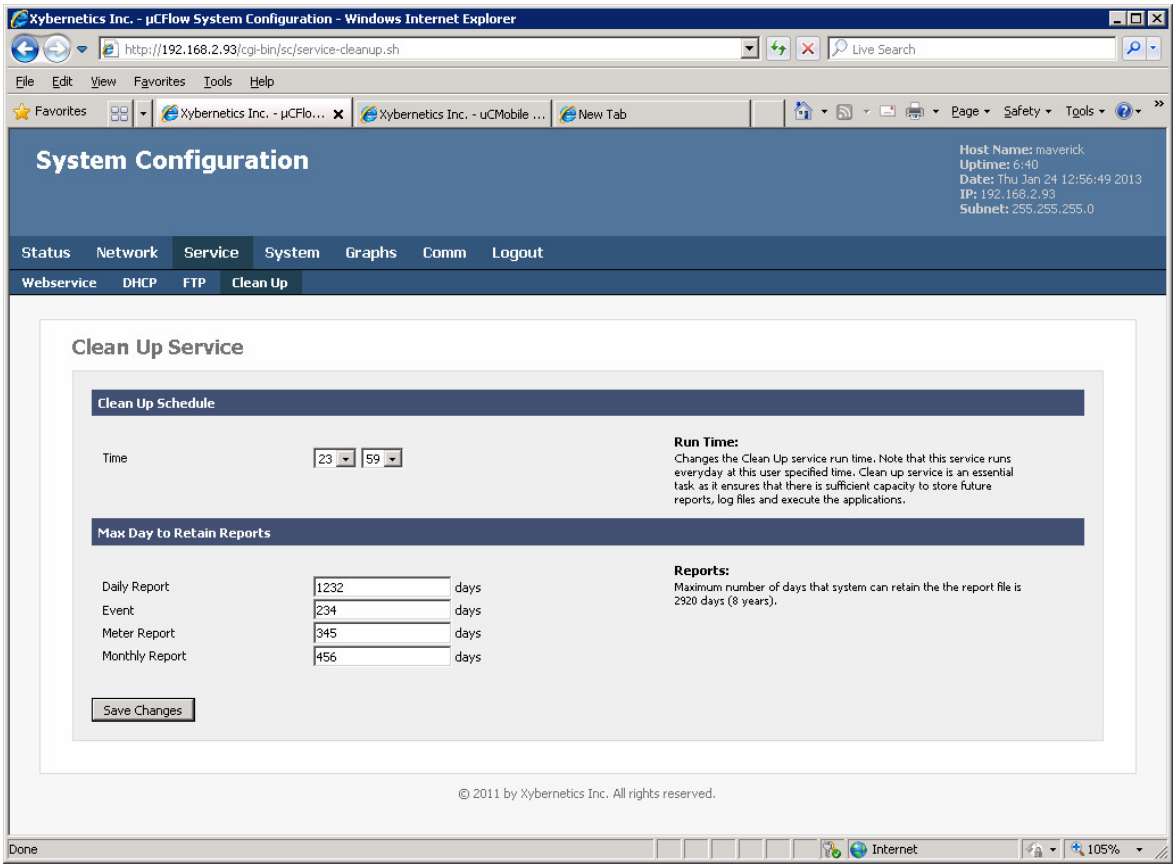
Xybernetics Inc. - µCFlow System Configuration - Windows Internet Explorer
http://192.168.2.93/cgi-bin/sc/service-cleanup.sh
System Configuration
Host Name: maverick
Uptime: 6:40
Date: Thu Jan 24 12:56:49 2013
IP: 192.168.2.93
Subnet: 255.255.255.0
Status Network Service System Graphs Comm Logout
Webservice DHCP FTP Clean Up
Clean Up Service
Clean Up Schedule
Time
23
59
Run Time:
Changes the Clean Up service run time. Note that this service runs everyday at this user specified time. Clean up service is an essential task as it ensures that there is sufficient capacity to store future reports, log files and execute the applications.
Max Day to Retain Reports
Daily Report 1232 days
Event 234 days
Meter Report 345 days
Monthly Report 456 days
Reports:
Maximum number of days that system can retain the the report file is 2920 days (8 years).
Save Changes
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Figure 6.1.3D, Service Tab – Clean Up Service

6.1.4. System Tab

The Service Tab page has all the core controller configuration parameters and the additional controller hardware based functions and commands. The list below highlights all the parameters and functions that can be performed from this page.

- General System Settings
  - Allows user to view and change the following controller parameters
    - Hostname (can be used in the place of IP address when access web interface)
    - Current system date and time. User is able to view and edit current date and time.
    - Time zone. Automatic time adjustment with time zone selection.
- Logs
  - This page allows user to access Kernel log.
  - Also the log files can be filtered based on user defined keywords to allow easy trouble shooting.
- Users
  - This page allows administrators to add user, remove users and modify their password.
  - Adding user here allows user to access the Flow Calculation Parameter Configuration web pages, FTP server access and Wi-Fi connection to the controller. Regular users will not have access to the System Configuration web pages.
  - Only administrators are allowed to edit System Configuration web pages, Flow Calculation Parameter Configuration web pages, FTP server access and Wi-Fi connection to the controller.
  - Administrator user name will always be “admin” (without double quotes) and the admin password can be modified in this tab, however, username “admin” cannot be deleted.
- Persistence
  - This page allows user to manage persistence files for flow calculations. This is a tool for the purpose of backing up the current “snap-shot” of the flow calculation parameter. It should never be used as a tool to update the follow parameters. To update the flow parameter, use the “.aga” file or the Flow Calculation Configuration webpages.
  - Persistence file are used to save all flow calculation parameters in a single binary file for each meter run.
  - In the event of power cycle, he flow calculation software uses the persistence files to retrieve previous setting and continue with normal operation.
  - Persistence file can also be backed up and used on a new controller when the current controller is damaged.
  - Renaming the persistence file and loading it as a different meter run will cause issue to meter run that the file was originally copied from. Therefore, persistence file should never be renamed and uploaded into the controller.
  - The persistence file format is as follows "scPersist#.rag" where "#" is the meter run number.
  - If the communication between RTU/PLC/transmitter is on established, persistence file cannot be generated.
  - Power cycling the controller will also generate a default persistence file, if the persistence file is deleted or does not exist. If the persistence file exists the controller reads the existing persistence file.
  - If the persistence file already exists for a particular meter run, a new persistence file cannot be loaded for the same meter run. The existing persistence in the controller must be deleted before loading it.
  - These are the conditions when the persistence file is generated

- When any changes to the flow parameters are performed
- When a new ".aga" file is loaded

- Reboot
  - Allows user to apply soft restart to the controller.

Screenshot of each sub tabs are as shown below.

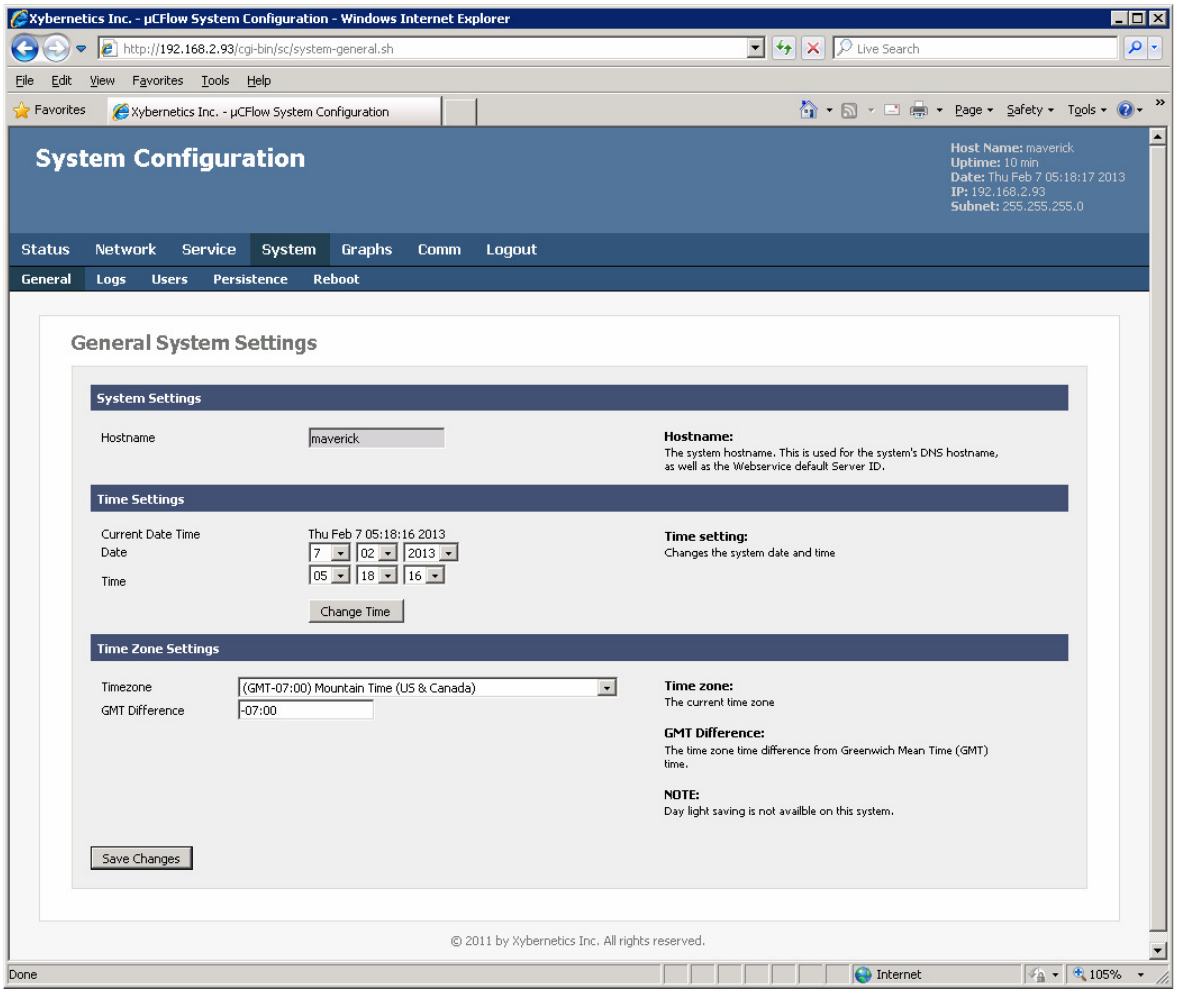


Figure 6.1.4A System Tab – System Tab - General

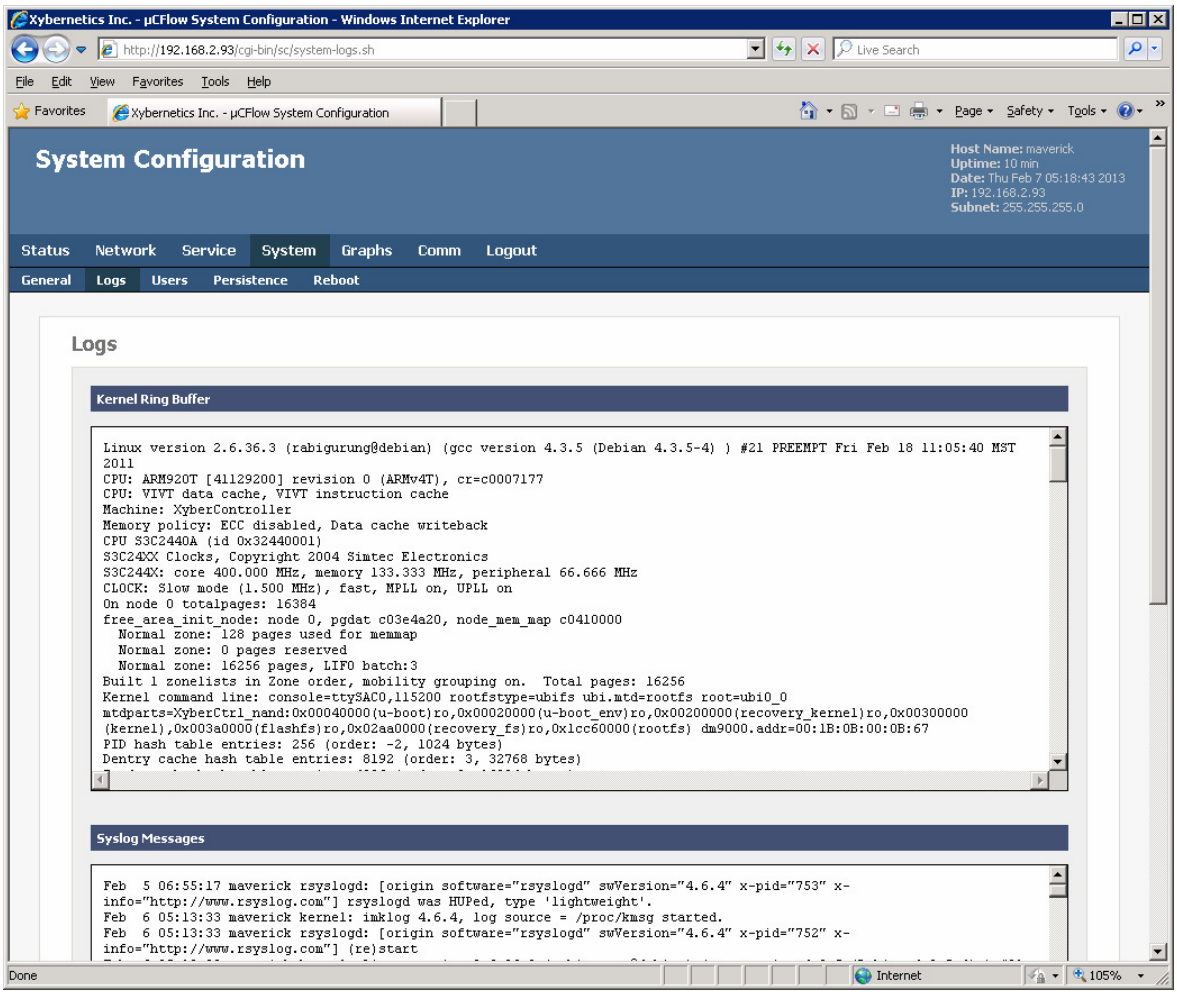

Xybernetics Inc. - µCFlow System Configuration - Windows Internet Explorer
http://192.168.2.93/cgi-bin/sc/system-logs.sh
File Edit View Favorites Tools Help
Xybernetics Inc. - µCFlow System Configuration
System Configuration
Host Name: maverick
Uptime: 10 min
Date: Thu Feb 7 05:18:43 2013
IP: 192.168.2.93
Subnet: 255.255.255.0
Status Network Service System Graphs Comm Logout
General Logs Users Persistence Reboot
Logs
Kernel Ring Buffer
Linux version 2.6.36.3 (rabigurung@debian) (gcc version 4.3.5 (Debian 4.3.5-4)) #21 PREEMPT Fri Feb 18 11:05:40 MST 2011
CPU: ARM920T [41129200] revision 0 (ARMv4T), cr=c0007177
CPU: VIVT data cache, VIVT instruction cache
Machine: XyberController
Memory policy: ECC disabled, Data cache writeback
CPU S3C2440A (id 0x32440001)
S3C24XX Clocks, Copyright 2004 Simtec Electronics
S3C244X: core 400.000 MHz, memory 133.333 MHz, peripheral 66.666 MHz
CLOCK: Slow mode (1.500 MHz), fast, MPLL on, UPLL on
On node 0 totalpages: 16384
free_area_init_node: node 0, pgdat c03e4a20, node_mem_map c0410000
Normal zone: 128 pages used for memmap
Normal zone: 0 pages reserved
Normal zone: 16256 pages, LIFO batch:3
Built 1 zonelists in Zone order, mobility grouping on. Total pages: 16256
Kernel command line: console=ttySAC0,115200 rootfstype=ubifs ubi.mtd=rootfs root=ubi0_0
mtdparts=XyberCtrl_nand:0x00040000(u-boot)ro,0x00020000(u-boot_env)ro,0x00200000(recovery_kernel)ro,0x00300000
(kernel),0x003a0000(flashfs)ro,0x02aa0000(recovery_fs)ro,0x1cc60000(rootfs) dm9000.addr=00:1B:0B:00:0B:67
PID hash table entries: 256 (order: -2, 1024 bytes)
Dentry cache hash table entries: 8192 (order: 3, 32768 bytes)
Syslog Messages
Feb 5 06:55:17 maverick rsyslogd: [origin software="rsyslogd" swVersion="4.6.4" x-pid="753" x-info="http://www.rsyslog.com"] rsyslogd was HUPed, type 'lightweight'.
Feb 6 05:13:33 maverick kernel: imklog 4.6.4, log source = /proc/kmsg started.
Feb 6 05:13:33 maverick rsyslogd: [origin software="rsyslogd" swVersion="4.6.4" x-pid="752" x-info="http://www.rsyslog.com"] (re)start
Done
Internet
105%

Figure 6.1.4B, System Tab – Log

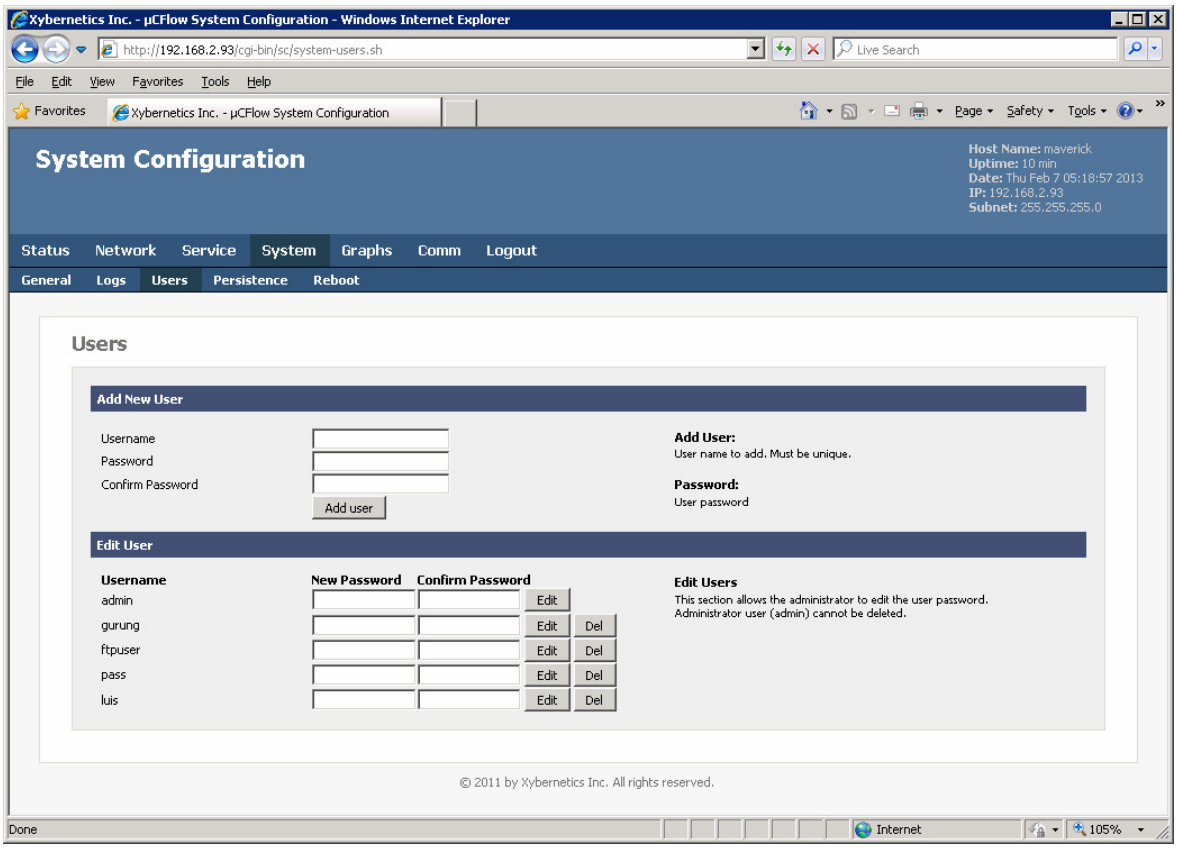


Figure 6.1.4C, System Tab – Users

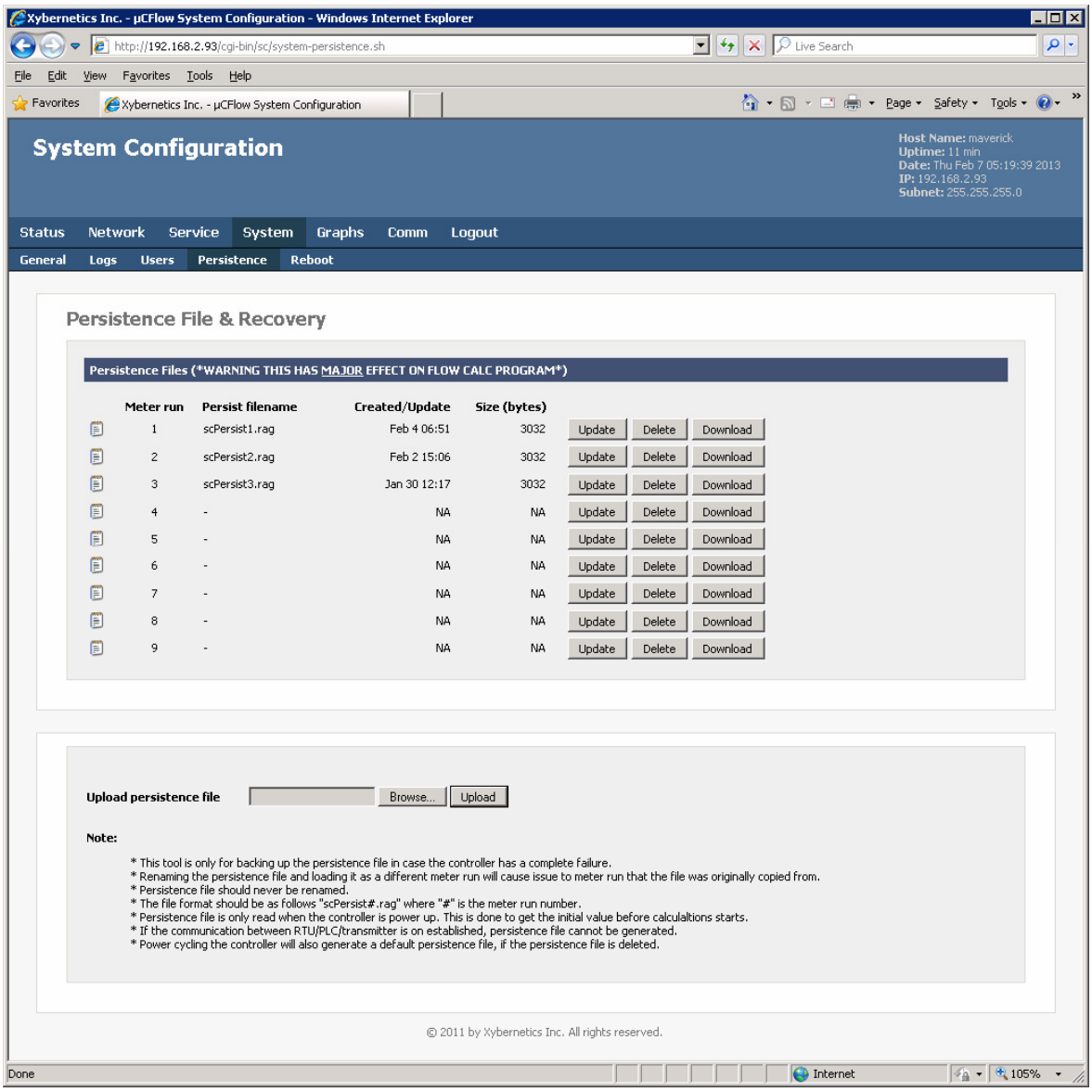

Xybernetics Inc. - µCFlow System Configuration - Windows Internet Explorer
http://192.168.2.93/cgi-bin/sc/system-persistence.sh
File Edit View Favorites Tools Help
Favorites
Xybernetics Inc. - µCFlow System Configuration
Page Safety Tools
System Configuration
Host Name: maverick
Uptime: 11 min
Date: Thu Feb 7 05:19:39 2013
IP: 192.168.2.93
Subnet: 255.255.255.0
Status Network Service System Graphs Comm Logout
General Logs Users Persistence Reboot
Persistence File & Recovery
Persistence Files (*WARNING THIS HAS MAJOR EFFECT ON FLOW CALC PROGRAM*)
Meter run Persist filename Created/Update Size (bytes)
1 scPersist1.rag Feb 4 06:51 3032 Update Delete Download
2 scPersist2.rag Feb 2 15:06 3032 Update Delete Download
3 scPersist3.rag Jan 30 12:17 3032 Update Delete Download
4 - NA NA Update Delete Download
5 - NA NA Update Delete Download
6 - NA NA Update Delete Download
7 - NA NA Update Delete Download
8 - NA NA Update Delete Download
9 - NA NA Update Delete Download
Upload persistence file
Browse...
Upload
Note:
* This tool is only for backing up the persistence file in case the controller has a complete failure.
* Renaming the persistence file and loading it as a different meter run will cause issue to meter run that the file was originally copied from.
* Persistence file should never be renamed.
* The file format should be as follows "scPersist#.rag" where "#" is the meter run number.
* Persistence file is only read when the controller is power up. This is done to get the initial value before calculaltions starts.
* If the communication between RTU/PLC/transmitter is on established, persistence file cannot be generated.
* Power cycling the controller will also generate a default persistence file, if the persistence file is deleted.
© 2011 by Xybernetics Inc. All rights reserved.
Done
Internet
105%

Figure 6.1.4D System Tab – Persistence

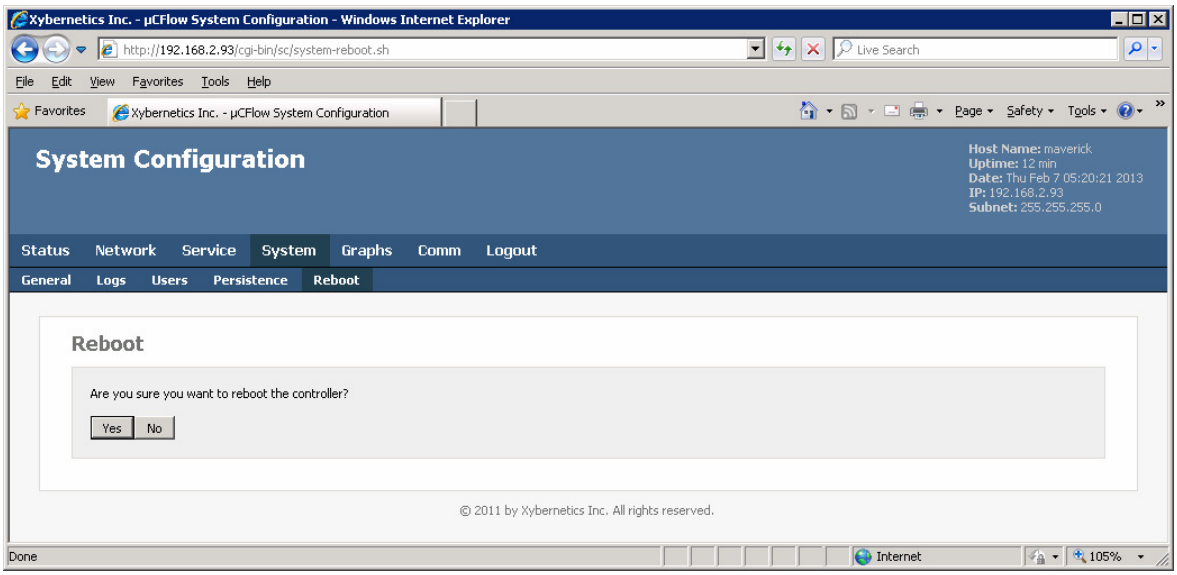


Figure 6.1.4E System Tab – Reboot

6.1.5. Graphs Tab

The Graphs Tab simply shows trending for CPU usage and Ethernet traffic in the Ethernet port. This page requires the user to download and install Adobe SVG Viewer before viewing this page. The viewer can be downloaded from this URL.

http://www.adobe.com/svg/viewer/install/

The screenshot below shows the trending in each tab.

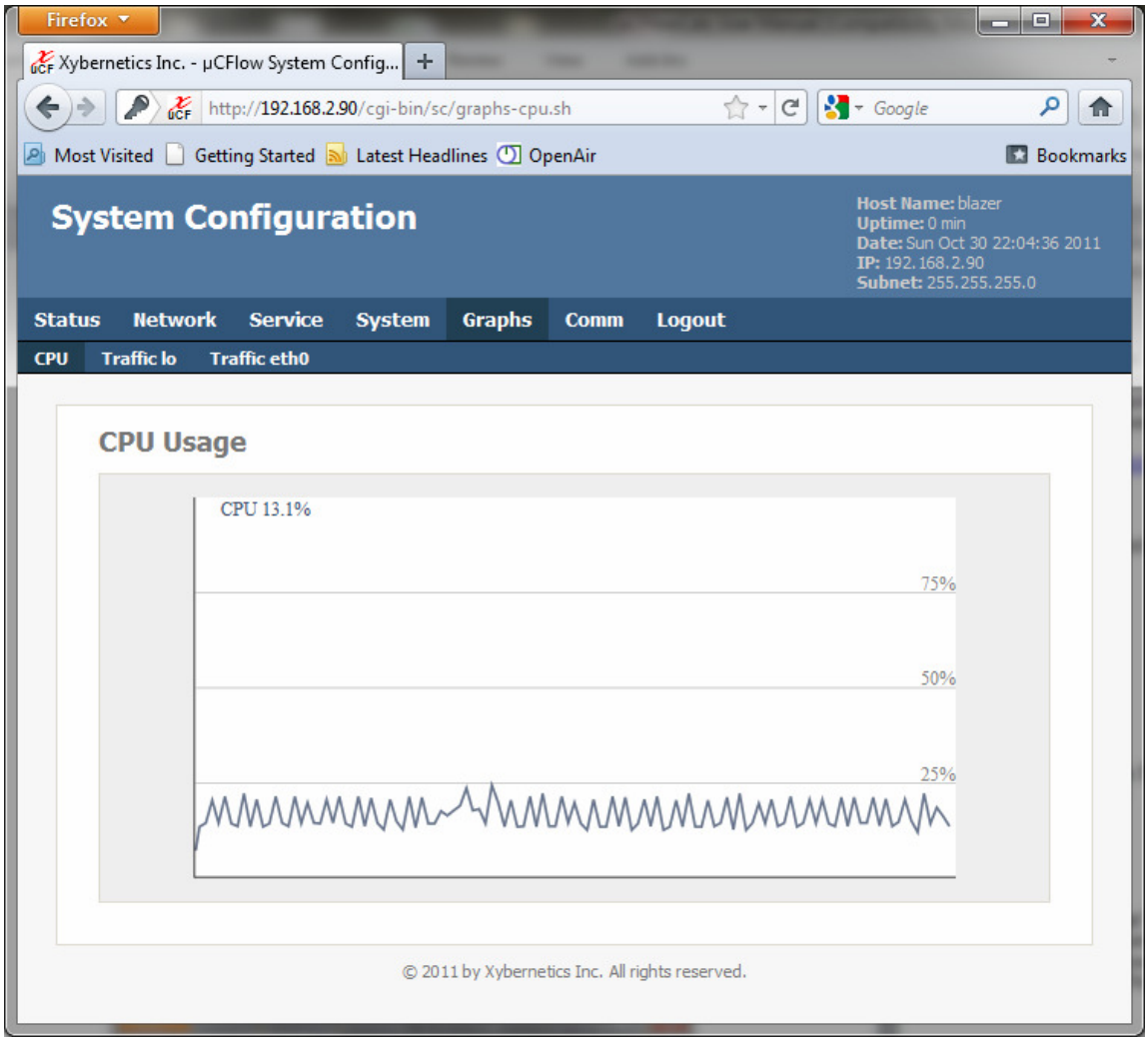


Figure 6.1.5A, Graphs – CPU Usage

6.1.6. Comm Tab

The page allows user to setup both TCP and serial Modbus slave parameters. The following are the slave parameter characteristics and a brief description.

- Modbus End Device Definition
  This section of the configuration handles communication setup between the controller and the RTU, PLC and/or transmitters. The user can setup up to 10 Modbus slave connections, and the slave could be mixture of both Modbus TCP and Modbus RTU (serial).
  - Communication Status
    - Enable or disables the Modbus slave communication channel.
    - If the Modbus slave is not required, it is highly recommended that the slave be disables. This will help reduce CPU usage and free up resources.
    - If the Communication Status is disabled, the communication program will check for the Communication Status change every 60 seconds.
  - Slave number
    - Changing this value will selectively change the communication slave channel and its associated communication parameters

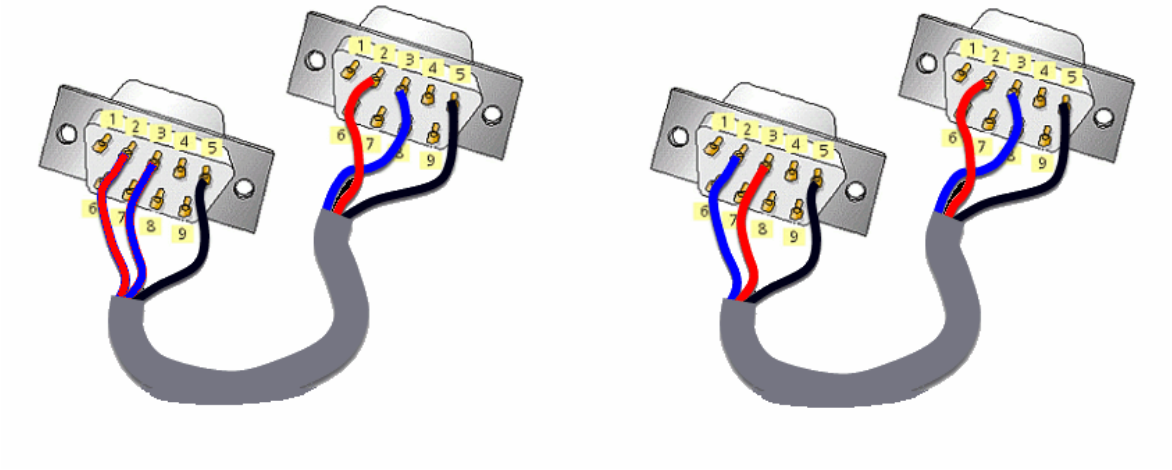
        - The flow computer is set to communicate to ten different communication channels.
    - Connection Type
        - There are two type of communication; TCP and serial.
        - Selecting either TCP or serial presents the user with the appropriate communication setup screen. For example TCP will have IP address entry while serial will have baud rate.
        - The serial selection will not be available to the user unless a serial port (either RS-232 or RS-485 cable) is connected to the controller (via USB)
    - IP address
        - IP address of the Modbus TCP slave device.
    - Port Number
        - Modbus TCP slave network port number
        - Port number 888 has been reserved for internal inter process communications and should not be used.
        - Maximum allowable port number is 65535
    - Baudrate
        - Modbus serial communication speed of data transfer.
    - Data Bits
        - Modbus serial communication data bits
    - Parity
        - Modbus serial communication parity.
    - Stop Bits
        - Modbus serial communication stop bits.
    - Station
        - Modbus slave station number
        - As per the Modbus communication standard, the range of station number is from 1 to 255 inclusive.
    - Timeout
        - Time delay (CPU sleep time) between each retries.
        - Max timeout is 128 seconds.
    - Number of Retries
        - Maximum number of retries before it is considered as timeout.
        - Maximum allowable number of retries is 128.
    - Poll Delay
        - Time delay between each successful polls (scan rate).
        - Max poll delay is 128 seconds.
    - No Respond Timeout
        - Time delay for slave to respond before connection is flagged as failed and retry sequence is performed.
        - Max allowed “No respond timeout” is 128 seconds.
    - Device Poll Type
        - There are 2 basic device poll type; Short and Full.
        - “Short” device poll type will poll basic 3 parameter to do flow calculations; static pressure, differential pressure and flow temperature. This setting is useful if the Modbus End Device is a Multi Variable Transmitter (MVS or better known as 3-in-1)
        - Selecting “Short” device poll type will allow user to enter Modbus register addresses for the 3 parameters; static pressure, differential pressure and flow temperature.
        - “Full” device poll type will poll the full 322 registers (See Appendix B) in the user specified holding register starting with register specified in the “Start Register”. This is useful in situation where the end device has all the parameters stored in the end device but is not able to do flow

calculations. For example, a RTU or PLC without flow calculations capabilities.

- Start Register
  - This allows user to specify the first Modbus register for the slave.
  - All registers must be holding registers (40000)
  - One poll block of Modbus register has a total of 139 registers in total. Hence, with 322 Modbus registers for "Full" device poll type, one meter run will require 2 Modbus polls.
- SP (Static Pressure) Register
  - This is an address for static pressure.
  - This option is available when the user selects "Short" device poll type.
  - An option is also available for the user to specify the type of holding register; 16bits or 32bit register.
- DP (Differential Pressure) Register
  - This is an address for differential pressure.
  - This option is available when the user selects "Short" device poll type.
  - An option is also available for the user to specify the type of holding register; 16bits or 32bit register.
- FT (Flow Temperature) Register
  - This is an address for flow temperature.
  - This option is available when the user selects "Short" device poll type.
  - An option is also available for the user to specify the type of holding register; 16bits or 32bit register.

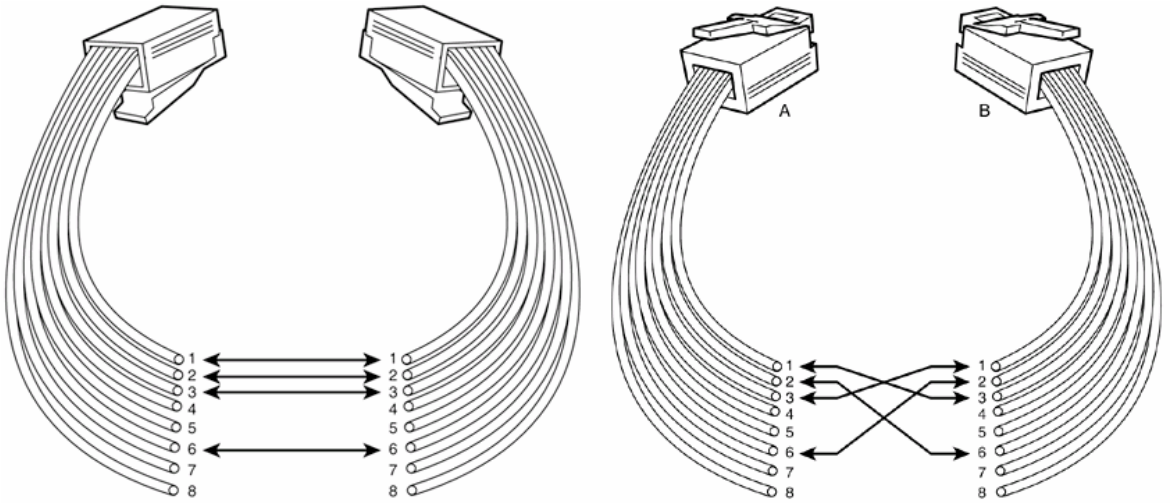
- Modbus Slave Definition
  This part of the communication configuration is for communication between controller and any Modbus Master that he user might want to connect to the controller. The controller will be a Modbus slave for that matter of fact; and it can be either Modbus TCP or Modbus RTU (serial).
  - Communication Status
    - Enable or disables the Modbus slave communication channel.
    - If the Modbus slave is not required, it is highly recommended that the slave be disables. This will help reduce CPU usage and free up resources.
    - If the Communication Status is disabled, the communication program will check for the Communication Status change every 60 seconds.
  - Connection Type
    - There are two type of communication; TCP and serial.
    - Selecting either TCP or serial presents the user with the appropriate communication setup screen. For example TCP will have IP address entry while serial will have baud rate.
    - The serial selection will not be available to the user unless a serial port (either RS-232 or RS-485 cable) is connected to the controller (via USB)
  - Port Number
    - Modbus TCP slave network port number
    - Port number 888 has been reserved for internal inter process communications and should not be used.
    - Maximum allowable port number is 65535
  - Station
    - Modbus slave station number
    - As per the Modbus communication standard, the range of station number is from 1 to 255 inclusive.

The serial communication does not use "Flow Control", hence it uses three-wired RS232 serial DB9 wiring schema. The diagram below shows pin out for both serial and Ethernet able.



Straight though **Crossover**

Figure X, DB 9 Cable Straight Though and Crossover Wiring Schema



Straight though **Crossover**

Figure X, Ethernet Cable Straight Though and Crossover Wiring Schema

If controller is connected directly to a computer or a laptop, a null modem cable is required. That is pin 2 and 3 must be crossed. For all other communication setup, a straight though cable can be used.

If this Modbus connection parameters are changed and would like to re-apply the new Modbus parameter without cycling the power, the user must do the following steps. Power down or stop the Modbus slave that is currently connected to and wait for retry delay (that is number of retries * no response timeout). Then start your new Modbus slave.

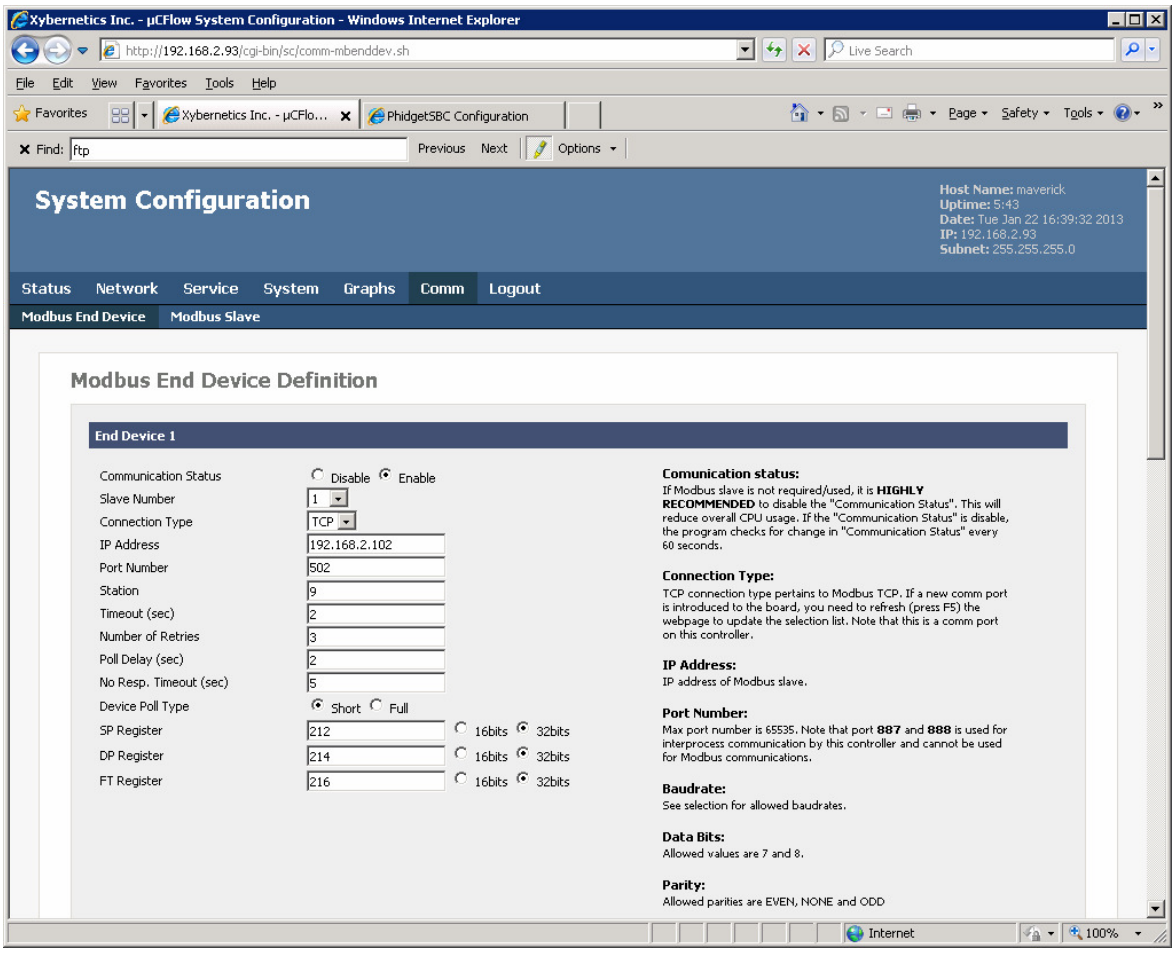

Xybernetics Inc. - µCFlow System Configuration - Windows Internet Explorer
http://192.168.2.93/cgi-bin/sc/comm-mbenddev.sh
File Edit View Favorites Tools Help
Xybernetics Inc. - µCFlo...
PhidgetSBC Configuration
Find: ftp
Previous Next Options
System Configuration
Host Name: maverick
Uptime: 5:43
Date: Tue Jan 22 16:39:32 2013
IP: 192.168.2.93
Subnet: 255.255.255.0
Status Network Service System Graphs Comm Logout
Modbus End Device Modbus Slave
Modbus End Device Definition
End Device 1
Communication Status Disable Enable
Slave Number 1
Connection Type TCP
IP Address 192.168.2.102
Port Number 502
Station 9
Timeout (sec) 2
Number of Retries 3
Poll Delay (sec) 2
No Resp. Timeout (sec) 5
Device Poll Type Short Full
SP Register 212 16bits 32bits
DP Register 214 16bits 32bits
FT Register 216 16bits 32bits
Comunication status:
If Modbus slave is not required/used, it is HIGHLY RECOMMENDED to disable the "Communication Status". This will reduce overall CPU usage. If the "Communication Status" is disable, the program checks for change in "Communication Status" every 60 seconds.
Connection Type:
TCP connection type pertains to Modbus TCP. If a new comm port is introduced to the board, you need to refresh (press F5) the webpage to update the selection list. Note that this is a comm port on this controller.
IP Address:
IP address of Modbus slave.
Port Number:
Max port number is 65535. Note that port 887 and 888 is used for interprocess communication by this controller and cannot be used for Modbus communications.
Baudrate:
See selection for allowed baudrates.
Data Bits:
Allowed values are 7 and 8.
Parity:
Allowed parities are EVEN, NONE and ODD
Internet
100%

Figure 6.1.6A, Comm Tab – Modbus End Device

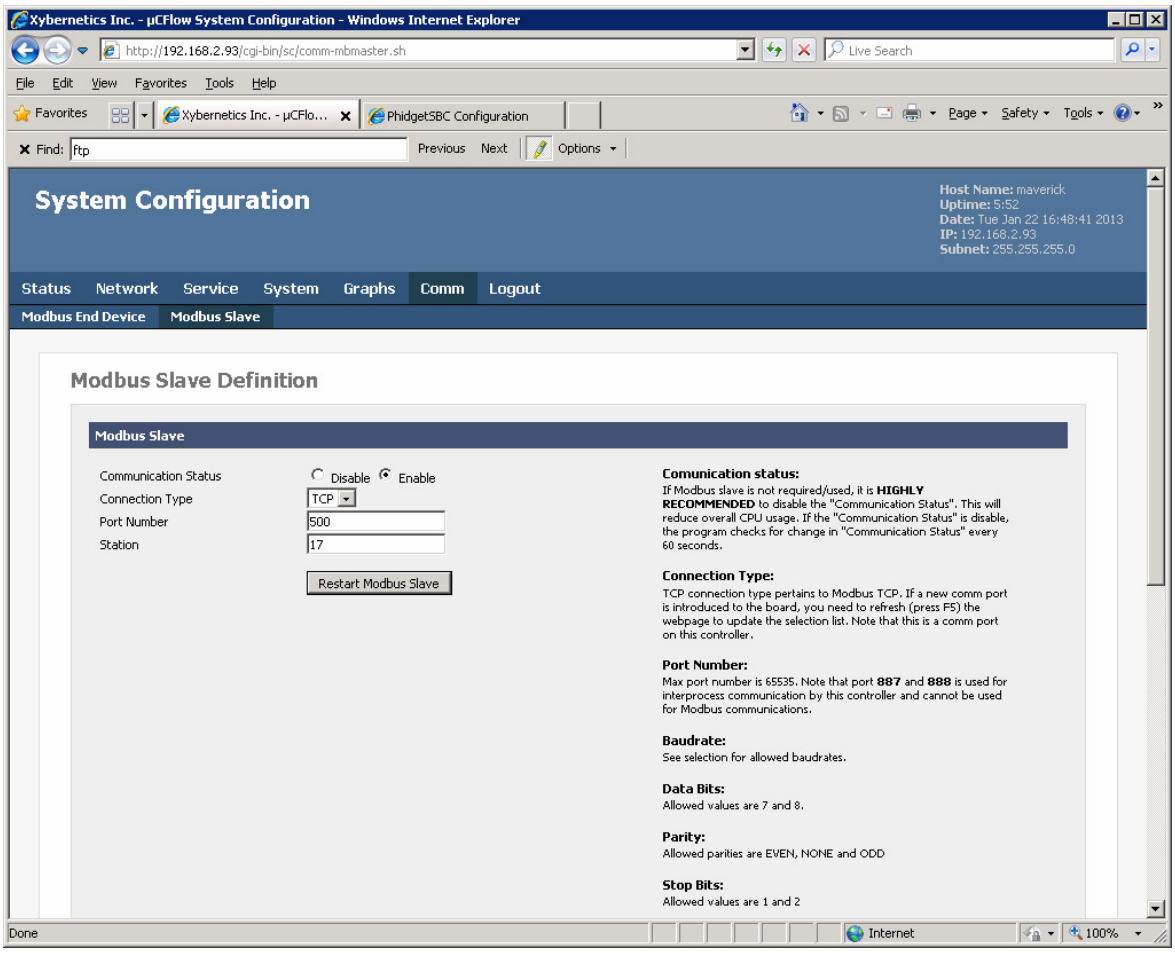

Xybernetics Inc. - µCFlow System Configuration - Windows Internet Explorer
http://192.168.2.93/cgi-bin/sc/comm-mbmaster.sh
File Edit View Favorites Tools Help
Xybernetics Inc. - µCFlo...
PhidgetSBC Configuration
Find: ftp
Previous Next Options
System Configuration
Host Name: maverick
Uptime: 5:52
Date: Tue Jan 22 16:48:41 2013
IP: 192.168.2.93
Subnet: 255.255.255.0
Status Network Service System Graphs Comm Logout
Modbus End Device Modbus Slave
Modbus Slave Definition
Modbus Slave
Communication Status
Disable Enable
Connection Type
TCP
Port Number
500
Station
17
Restart Modbus Slave
Comunication status:
If Modbus slave is not required/used, it is HIGHLY RECOMMENDED to disable the "Communication Status". This will reduce overall CPU usage. If the "Communication Status" is disable, the program checks for change in "Communication Status" every 60 seconds.
Connection Type:
TCP connection type pertains to Modbus TCP. If a new comm port is introduced to the board, you need to refresh (press F5) the webpage to update the selection list. Note that this is a comm port on this controller.
Port Number:
Max port number is 65535. Note that port 887 and 888 is used for interprocess communication by this controller and cannot be used for Modbus communications.
Baudrate:
See selection for allowed baudrates.
Data Bits:
Allowed values are 7 and 8.
Parity:
Allowed parities are EVEN, NONE and ODD
Stop Bits:
Allowed values are 1 and 2
Done
Internet
100%

Figure 6.1.6B, Comm Tab – Modbus Slave

6.1.7. Logout Tab

All user login are maintained on the computer session variable. The user must logout before closing the browser to prevent unauthorized users from viewing and changing the system parameters. This page allows users to logout form the session variable.

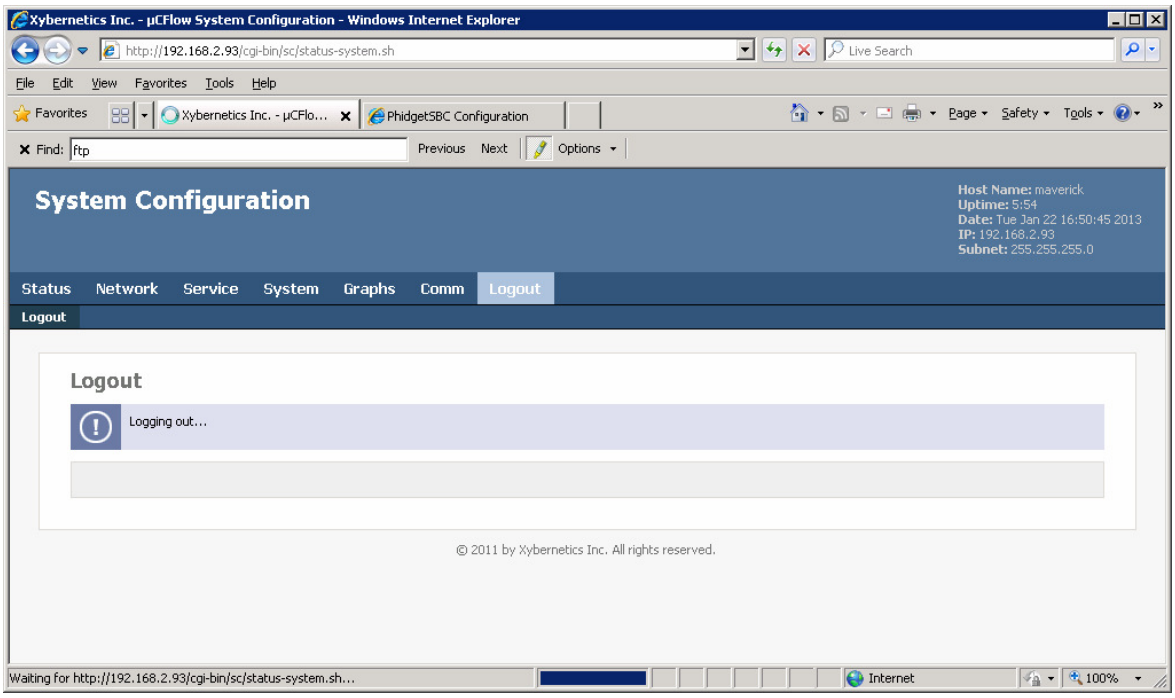


Figure 6.1.7A, Logout Tab

6.2. Flow Calculation Configuration

A typical flow calculation has several inputs and outputs parameters. This section covers configuration of these parameters.

The top section of the webpage is the tab menu which allows users to navigate through all the flow calculation parameters. Some of the tabs will be changed based on the modification of the user entry parameters. For example, if AGA7 was selected as a flow calculation method, AGA7 tab will be displayed and AGA3 will be hidden.

The flow calculation program has been designed to handle ten meter runs. The sidebar (as shown in figure below) allows the user to move from the current meter run to the desired meter run. The text below “Calc Results” tab verifies that the meter run number has been changed and proper flow calculation parameters has been loaded into the Flow Calculation Configuration web interface.

Currently logged in username is shown on the top left-hand side of the webpage (next to logout hyperlink). Once the user is done with the configuration, the login session can be terminated using the logout hyperlink on the top right-hand side of the web page.

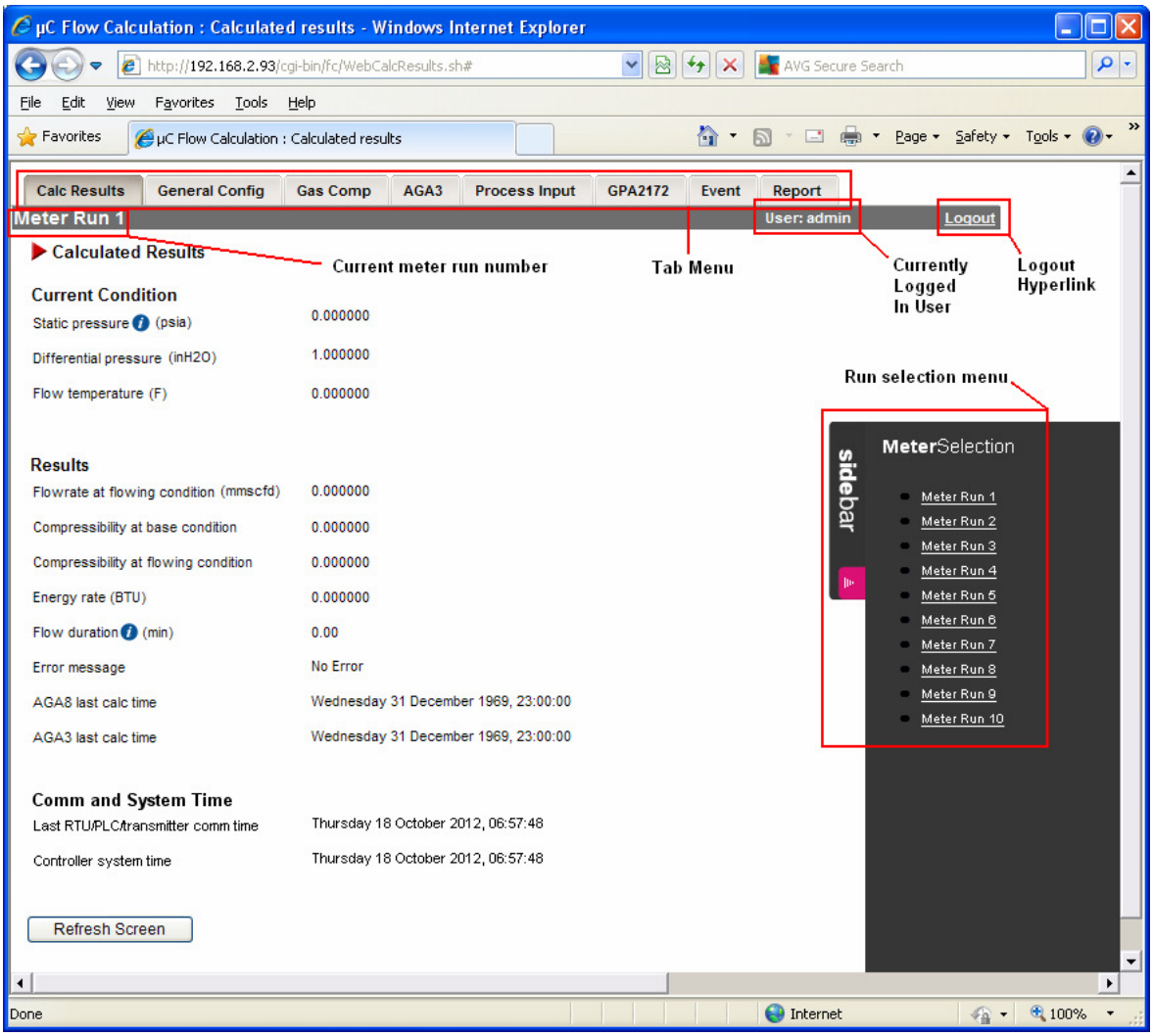


Figure 6.2A, Flow Calculation Configuration

The flow calculation parameters have been grouped into different tabs based on flow calculation method and its functions.

6.2.1. Calculation Results

This page displays the calculated results of the flow calculation depending on the type of flow calculation selected. The following are the available flow calculation methods.

- AGA3
- AGA7
- Wafer Cone
- V-Cone

The following information is available in this web page.

- Current Condition (general input)
  - AGA3
    - Static pressure
    - Differential pressure
    - Flow temperature

    - AGA7
        - Static pressure
        - Flow temperature
    - Wafer Cone and V-Cone
        - Static pressure
        - Differential pressure
        - Flow temperature
- Results (output) For AGA3
    - Flowrate
    - Compressibility (base and flowing condition)
    - Energy rate
    - Flow duration
        - Flow duration will not start if the input values are in debug mode. For example for AGA3 if the static pressure, differential pressure or flow temperature is enabled (checked) in “Process Value” tab, the flow duration will not increase.
    - Error message
        - See Appendix B for Error messages
    - AGA8 last calculation time
    - AGA3 Last calculation time
- Results (output) For AGA7
    - Flowrate
    - Energy rate
    - Flow duration
        - Flow duration will not start if the input values are in debug mode. For example for AGA3 if the static pressure, differential pressure or flow temperature is enabled (checked) in “Process Value” tab, the flow duration will not increase.
    - Error message
        - See Appendix B for Error messages
- Results (output) For Wafer and V-Cone
    - Flowrate
    - Compressibility (base and flowing condition)
    - Energy rate
    - Flow duration
        - Flow duration will not start if the input values are in debug mode. For example for AGA3 if the static pressure, differential pressure or flow temperature is enabled (checked) in “Process Value” tab, the flow duration will not increase.
    - Error message
        - See Appendix B for Error messages
- Communication and System Time
    - Last RTU/PLC/transmitter communication time
        - A red background text will be visible if the communication to the PLC is lost, and the “Last RTU/PLC/transmitter comm time” entry will be at the frozen state. The red tab is as shown below.

    - Controller system time
        - Controller system time can be changed though Modbus (see Appendix B) or though System Configuration webpage (see System Tab->General)

The engineering units will be changed dynamically based on the “Input eng unit” and/or “Output eng unit” pull down box(es) in the “General Config” tab.

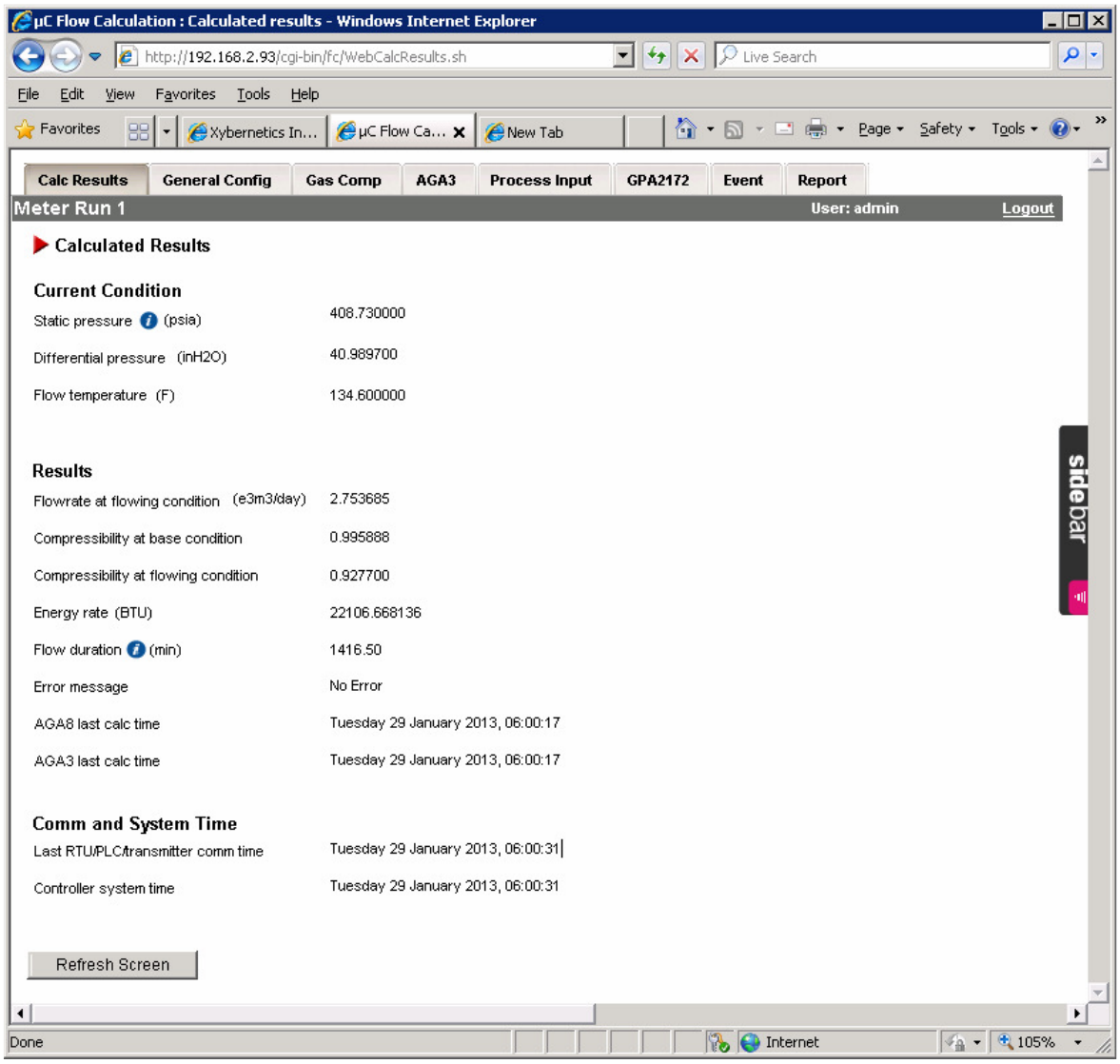


Figure 6.2.1A, Calculation Results Tab

6.2.2. General Configuration

In this screen of the Flow Calculation Configuration, the user is allowed to make typical flow calculation parameter changes. The following are the flow parameter that can be modified from this screen.

- Meter name
  - This name will be part of the report filename. For example, the Daily Report name for this run will be “201208_Test_Meter_DlyRpt.csv”. This meter name effects Daily, Monthly and Meter Report.
  - Maximum of 32 characters allowed.
  - Only alphanumeric characters are allowed.
  - Space is allowed.
  - First character can be number
- Flow calculation method

    - Selecting the appropriate flow calculation method will make appropriate tab visible. For example, if “AGA3” is selected, the “AGA3” tab will be visible. And if “AGA7 is selected, “AGA7” tab will be visible.
- Compressor calculation method
- Compressor gross method
    - This selection is not selectable (greyed out) when “AGA8 Detail” is chosen in “Compressor calculation method”.
- Heating value calculation method
- Contract hour
    - This value has to be entered in 24-hours clock format; 0 to 23 hours.
- Input engineering unit
    - If the input values are entered in matrix or imperial, this is where the changes are to be made.
    - This effect instantaneous and non-instantaneous (such as gas composition) value.
- Output engineering unit
    - If the output values are preferred in matrix or imperial, this is where the changes are to be made
    - This change effect only the final output/calculated value.
- Base temperature
- Base pressure
- Static pressure type
    - This entry allows user to specify the static pressure reading type; absolute ot gauge pressure.
- Atmospheric pressure mode
    - The flow calculation software has the capability to calculate atmospheric pressure. If “Calculated” is selected for this entry, user must ensure that altitude and latitude is entered correctly.
- Latitude
    - Used for the calculation of atmospheric pressure if “Atmospheric pressure mode” is in “Calculated” mode.
- Altitude
    - Used for the calculation of atmospheric pressure if “Atmospheric pressure mode” is in “Calculated” mode.
- Atmospheric pressure
    - This atmospheric pressure is used if the “Atmospheric pressure mode” is selected as “Manual”.

All the Flow Parameters Load File can be saved and loaded from this tab through the “Config File” entry section. After loading the Flow Parameter Load File, the live flow calculation parameters are updated and the new flow parameters are applied to the calculation in 10 seconds (maximum). The load file is saved as “.aga” file and can be opened using any text editor. A sample of the Flow Parameters Load File can be found in Appendix A or in the following Xybernetics webpage under “Download” tab.

http://www.xybernetics.com/solutions-uCFlowCal.html

The current flow parameters can also be exported to a “.aga’ file. The user have to initially click on “Generate Config File” button which will create Flow Parameter Load File with the latest flow configuration. Upon clicking the button, a link “Config File Read for Download” will be available, where the user can click on it and retrieve the “.aga” file.

The engineering units will be changed dynamically based on the “Input eng unit” pull down box.

The General Configuration screen is as shown below.

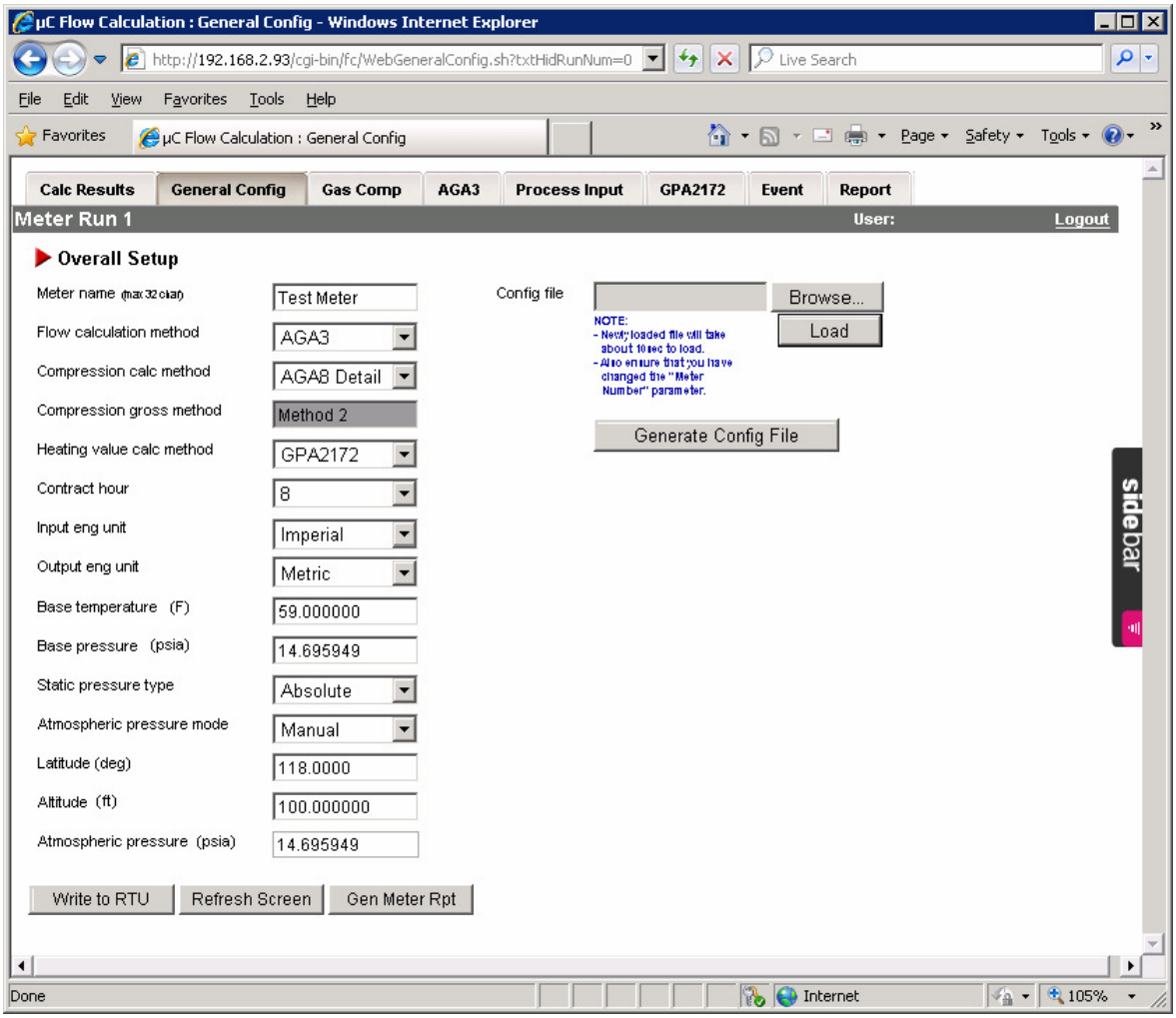


Figure 6.2.2A, General Config Tab

6.2.3. Gas Composition

In this tab, the user has the capability to modify all the twenty one (21) gas compositions and the specific gravity of the medium.

Before the gas composition is incorporated into flow calculation software, verification is done to ensure that the gas composition sums up to one (1). If it does not sum up to one (1), the “Total gas composition” is highlighted in red and the total is shown (as per user entry). The acceptable value of the total gas composition should be greater than or equal to 0.999995 and less than or equal to 1.000005.

If the “Specific gravity method” is set to “Calculated”, the user entry specific gravity will be disabled (grey out, not used for flow calculation algorithm) and the program will calculate the specific gravity based on user entered flow parameters.

The Gas Composition screen is as shown below.

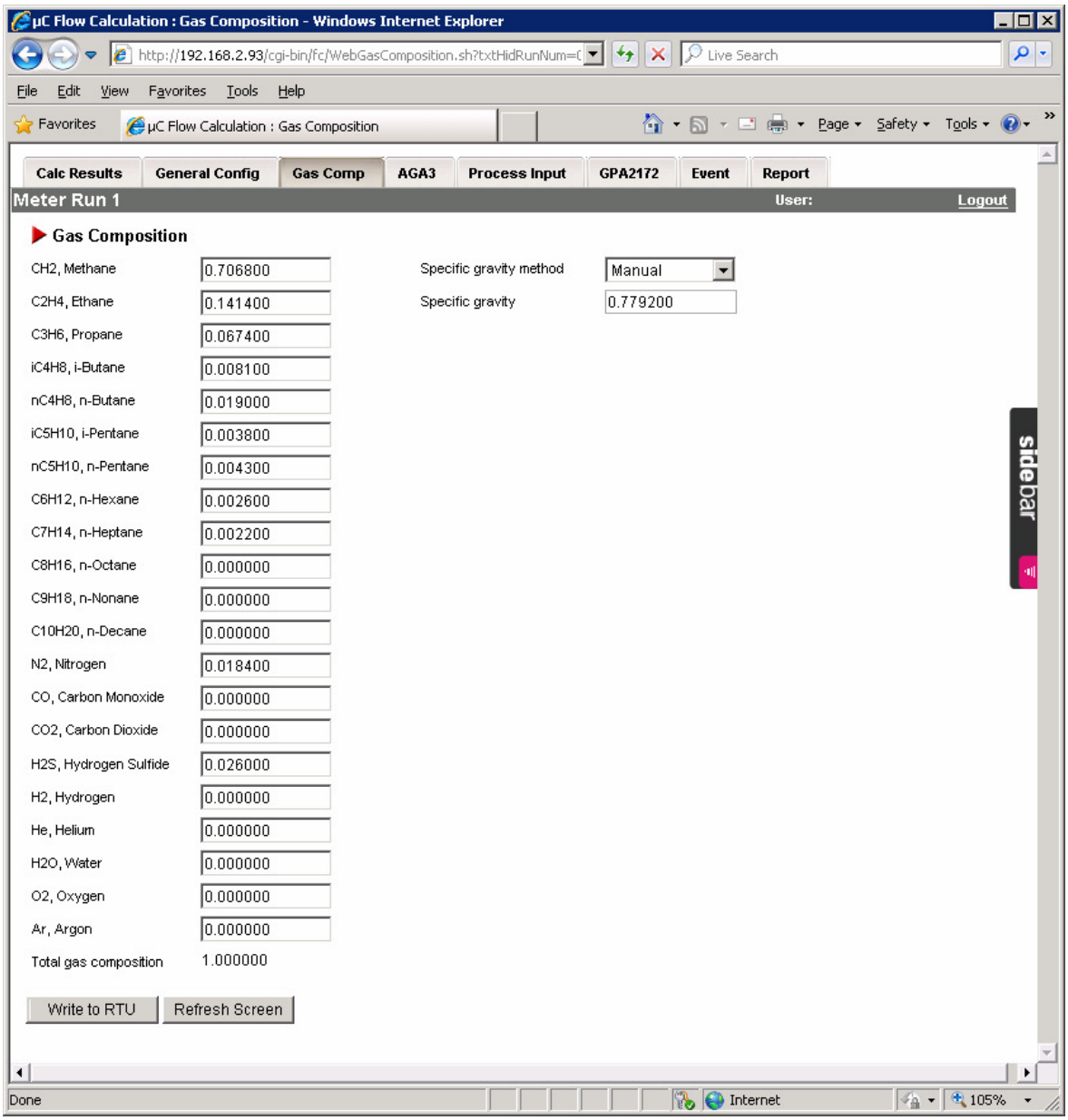


Figure 6.2.3A, Gas Composition Tab

6.2.4. AGA3

This tab is visible when the user has selected “AGA3” in the “Flow Calculation method” on the “General Config” tab.

If orifice plate is adopted as the flow meter, this tab will be available for the user to select. In this tab, the user is able to make modification to parameters pertaining to AGA3 flow calculation parameters.

The following AGA3 parameters can be modified.

- Orifice plate bore diameter
- Orifice plate material

- ipe internal diameter
- Pipe material
- Ref temp for plate and pipe
- Static tap location
- Isentropic
- Viscosity
- DP cutoff
- Correction factor

The engineering units will be changed dynamically based on the “Input eng unit” pull down box in the “General Config” tab.

The AGA3 screen is as shown below.

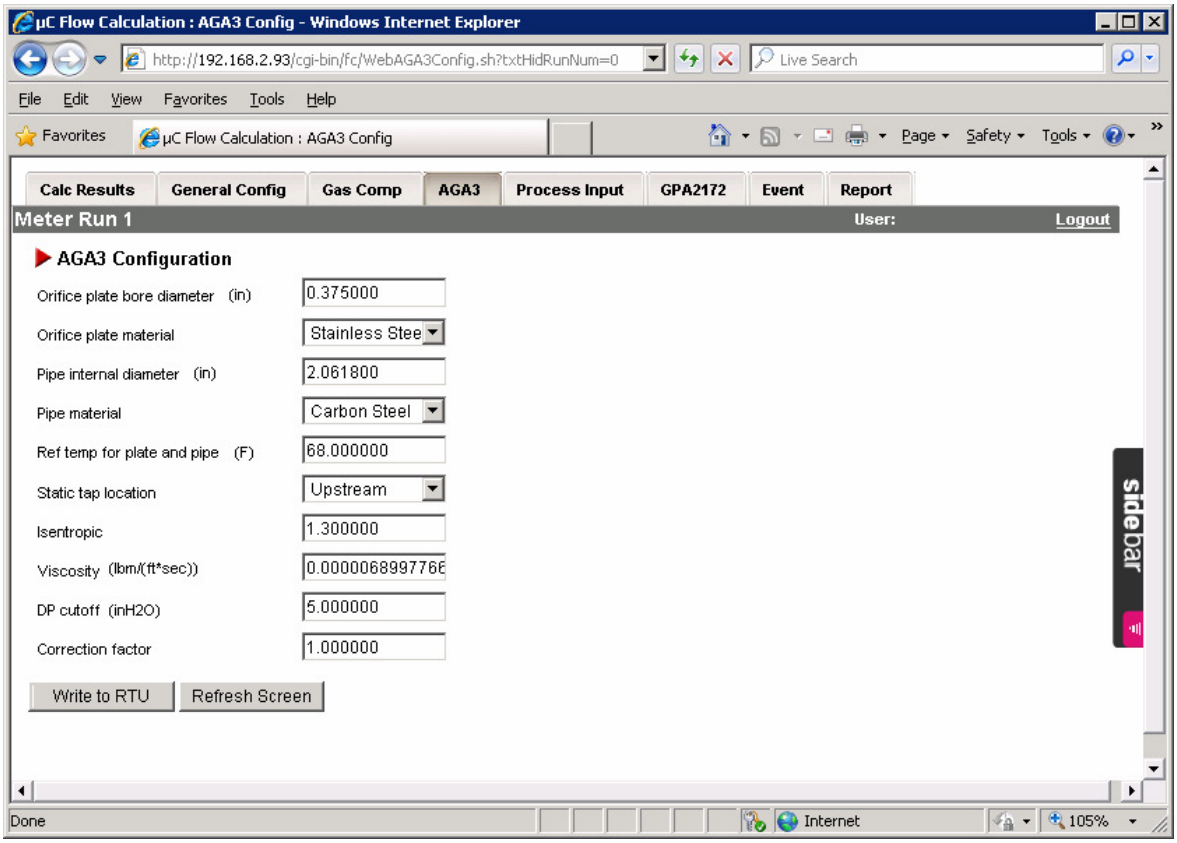


Figure 6.2.4A, AGA3 Tab

6.2.5. AGA7

This tab is visible when the user has selected “AGA7” in the “Flow Calculation method” on the “General Config” tab.

If turbine meter is adopted as the flow meter, this tab will be available for the user to select. In this tab, the user is able to make modification to parameters pertaining to AGA7 flow calculation parameters.

The following AGA7 parameters can be modified.

- k-factor
- Unit time

The engineering units will be changed dynamically based on the “Input eng unit” pull down box in the “General Config” tab.

The AGA7 screen is as shown below.

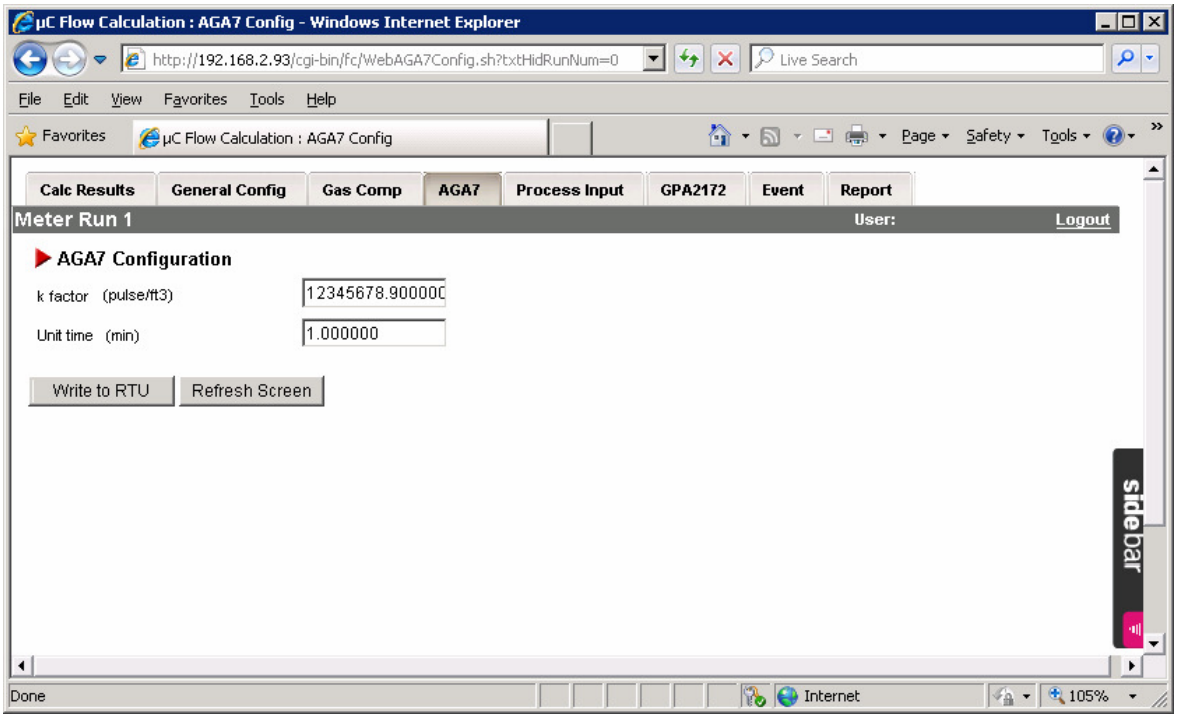


Figure 6.2.5A, AGA7 Tab

6.2.6. Process Value

This section of the Flow Calculation Configuration allows the user to put the controller into debugging mode and enables the user to force a value to the instantaneous values; such as static pressure, differential pressure and flow temperature.

This tool is useful during the commissioning process where the user can for a value to the abovementioned instantaneous value and simulate flow. It is also valuable when performing bench test of communication interface between the controller and a HMI, without needing the actual transmitters.

Here are some of the key pointers to be aware if you put the instantaneous value(s) in debugging mode.

- If any of the instantaneous values are in debugging mode, a red banner will appear above the Flow Configuration screen. Also in the “Calc Results” tab, a yellow banner next to the instantaneous value will highlight which one is in debugging mode.
- If any of the input values are in debug mode, the regular poll to acquire static pressure, differential pressure and flow temperature is temporarily disabled.

In this section, the user can also enter deadband and calibration ranges for the instantaneous values such as static pressure, differential pressure and flow temperature.

The engineering units will be changed dynamically based on the “Input eng unit” pull down box in the “General Config” tab.

The Process Value screen is as shown below.

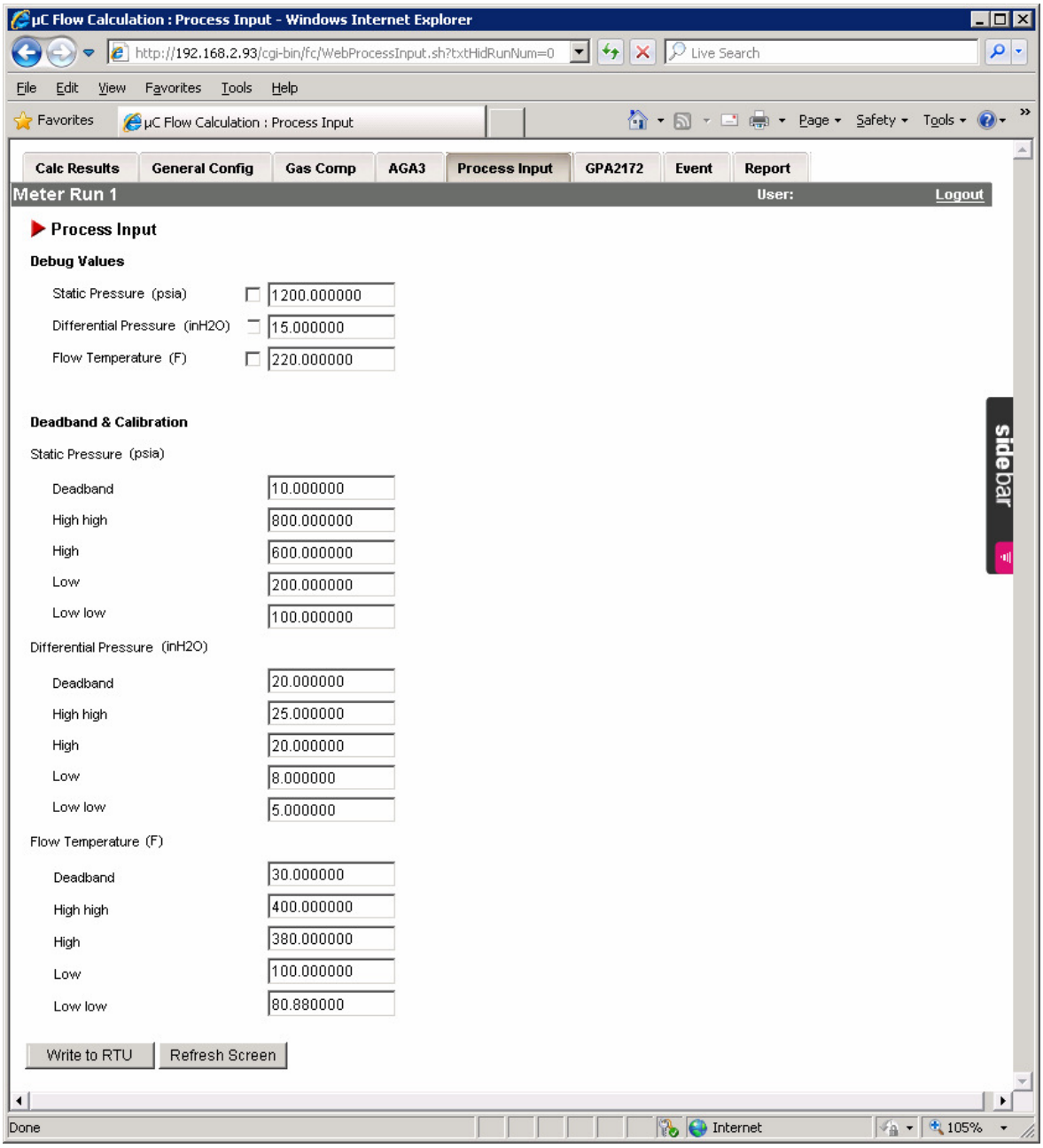


Figure 6.2.6A, Process Input Tab

6.2.7. GPA2172 Value

If the user were to select the “Heating Value Calculation Method” as GPA2172, this tab will be visible.

The engineering units will be changed dynamically based on the “Input eng unit” pull down box in the “General Config” tab.

The GPA2172 Value screen is as shown below.

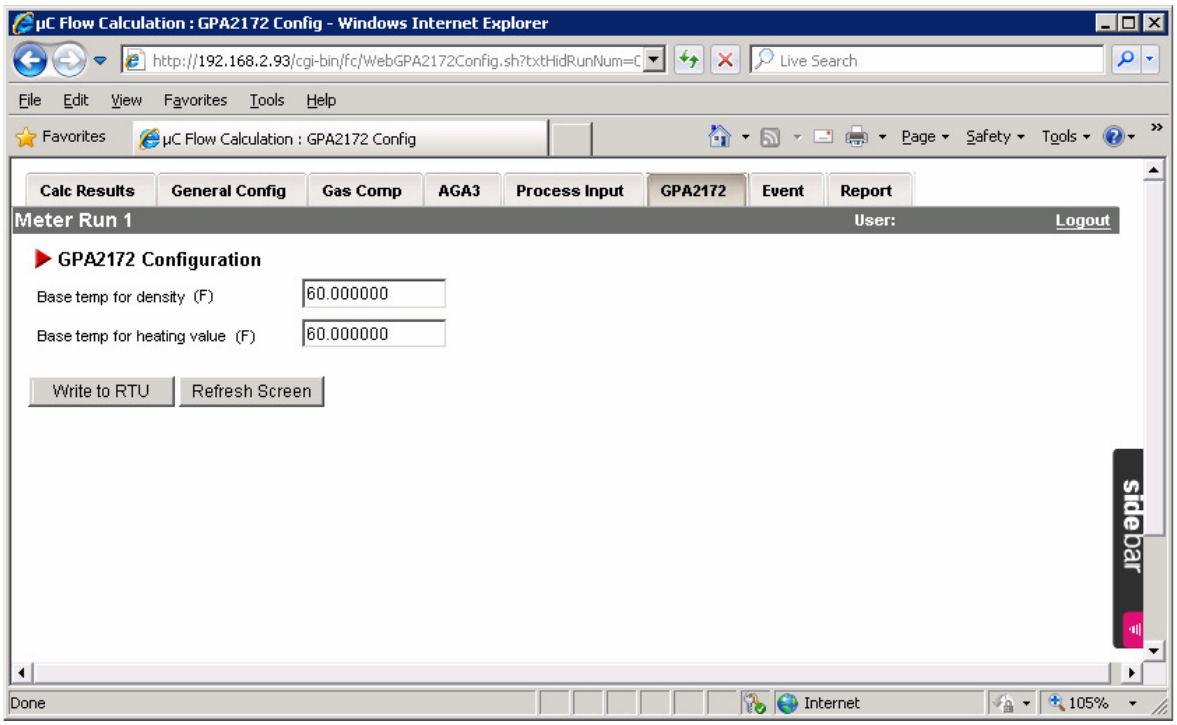


Figure 6.2.7A, GPA2172 Tab

6.2.8. Event

The Event log will display all actions that were performed in the controller with username associated to the action.

There are several purposes of this log and they are as listed below

- For the purpose of future appraisal and record keeping
- Identify what changes were made
- For the purpose of auditing by the local governing body

The event log captures the following events.

- Power cycle of controller
- Communication loss and establishment of the Modbus master and slave
- Disconnection and reconnection of the Ethernet cable
- System time change
- Any flow calculation parameter changes from Flow Calculation Configuration webpage
- Any flow calculation parameter changes from “Config file” upload

The event logs shown in the web page are based on meter run. If the user wants to watch another meter run event log, the user can change the “Event log file” pull down box (as shown below). A new event log file will be generated when the month changes.

The Event screen is as shown below.

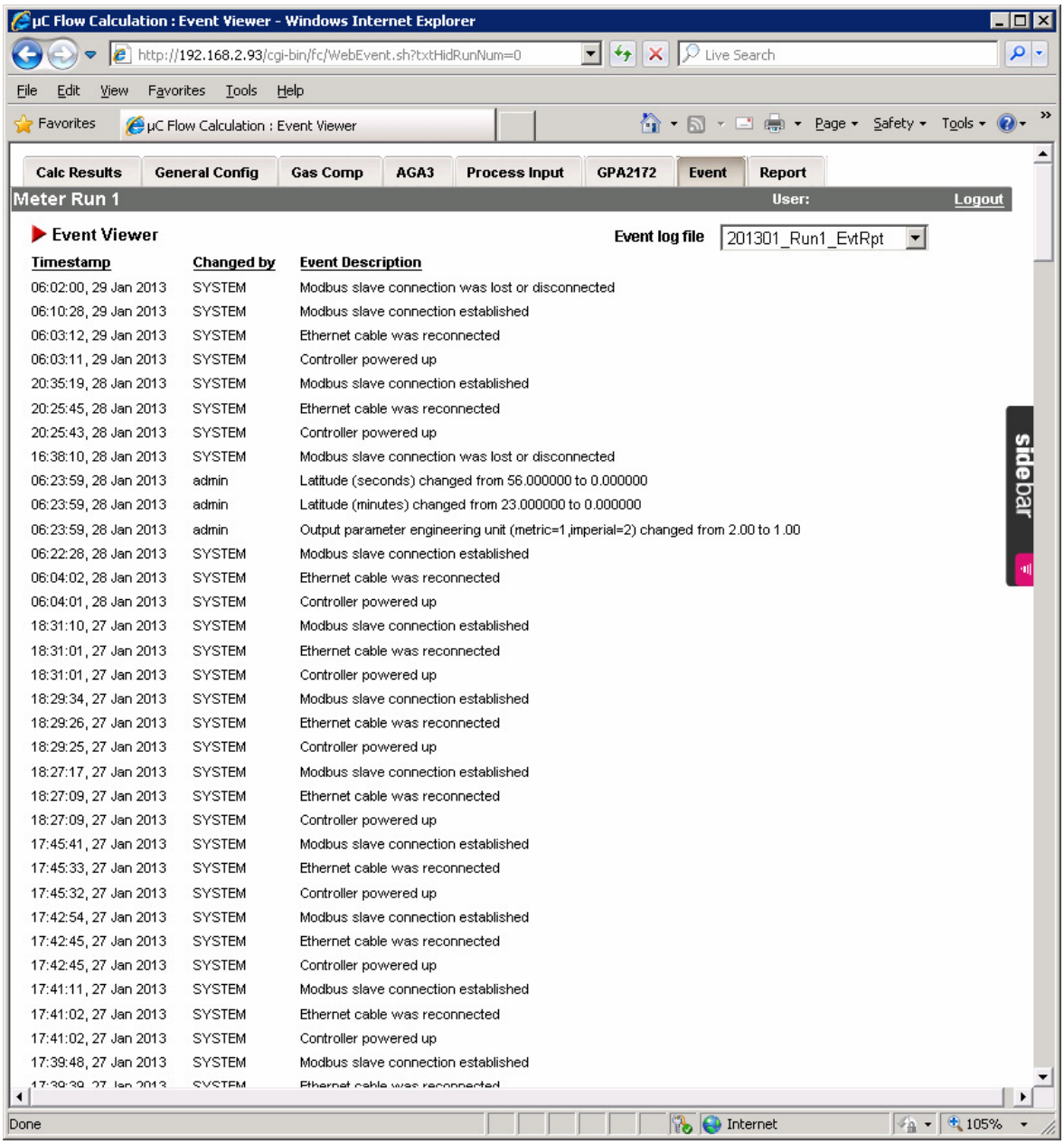

µC Flow Calculation : Event Viewer - Windows Internet Explorer
http://192.168.2.93/cgi-bin/fc/WebEvent.sh?txtHidRunNum=0
Live Search
File Edit View Favorites Tools Help
Favorites
µC Flow Calculation : Event Viewer
Page Safety Tools
Calc Results
General Config
Gas Comp
AGA3
Process Input
GPA2172
Event
Report
Meter Run 1
User:
Logout
Event Viewer
Event log file
201301_Run1_EvtRpt
Timestamp
Changed by
Event Description
06:02:00, 29 Jan 2013 SYSTEM Modbus slave connection was lost or disconnected
06:10:28, 29 Jan 2013 SYSTEM Modbus slave connection established
06:03:12, 29 Jan 2013 SYSTEM Ethernet cable was reconnected
06:03:11, 29 Jan 2013 SYSTEM Controller powered up
20:35:19, 28 Jan 2013 SYSTEM Modbus slave connection established
20:25:45, 28 Jan 2013 SYSTEM Ethernet cable was reconnected
20:25:43, 28 Jan 2013 SYSTEM Controller powered up
16:38:10, 28 Jan 2013 SYSTEM Modbus slave connection was lost or disconnected
06:23:59, 28 Jan 2013 admin Latitude (seconds) changed from 56.000000 to 0.000000
06:23:59, 28 Jan 2013 admin Latitude (minutes) changed from 23.000000 to 0.000000
06:23:59, 28 Jan 2013 admin Output parameter engineering unit (metric=1,imperial=2) changed from 2.00 to 1.00
06:22:28, 28 Jan 2013 SYSTEM Modbus slave connection established
06:04:02, 28 Jan 2013 SYSTEM Ethernet cable was reconnected
06:04:01, 28 Jan 2013 SYSTEM Controller powered up
18:31:10, 27 Jan 2013 SYSTEM Modbus slave connection established
18:31:01, 27 Jan 2013 SYSTEM Ethernet cable was reconnected
18:31:01, 27 Jan 2013 SYSTEM Controller powered up
18:29:34, 27 Jan 2013 SYSTEM Modbus slave connection established
18:29:26, 27 Jan 2013 SYSTEM Ethernet cable was reconnected
18:29:25, 27 Jan 2013 SYSTEM Controller powered up
18:27:17, 27 Jan 2013 SYSTEM Modbus slave connection established
18:27:09, 27 Jan 2013 SYSTEM Ethernet cable was reconnected
18:27:09, 27 Jan 2013 SYSTEM Controller powered up
17:45:41, 27 Jan 2013 SYSTEM Modbus slave connection established
17:45:33, 27 Jan 2013 SYSTEM Ethernet cable was reconnected
17:45:32, 27 Jan 2013 SYSTEM Controller powered up
17:42:54, 27 Jan 2013 SYSTEM Modbus slave connection established
17:42:45, 27 Jan 2013 SYSTEM Ethernet cable was reconnected
17:42:45, 27 Jan 2013 SYSTEM Controller powered up
17:41:11, 27 Jan 2013 SYSTEM Modbus slave connection established
17:41:02, 27 Jan 2013 SYSTEM Ethernet cable was reconnected
17:41:02, 27 Jan 2013 SYSTEM Controller powered up
17:39:48, 27 Jan 2013 SYSTEM Modbus slave connection established
sidebar
Done
Internet
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Figure 6.2.8A, Event Tab

The event log is a CSV file and can be opened using Microsoft Excel or any text editor. This CSV file can be downloaded from the “Report” tab and by selecting “Event Log” from the “Report Type” pull down box. The downloading of the event log and reports are discussed further in the next section.

An example of a typical log file is as shown below.

```
1350974108.000000,1.00,2.00,5,admin
1350972886.000000,56.000000,0.000000,42,admin
1350972886.000000,23.000000,0.000000,41,admin
1350972886.000000,2.00,1.00,5,admin
```

```
1350972855.000000,0,0,2004,SYSTEM
1350972082.000000,0,0,2001,SYSTEM
1350972081.000000,0,0,2002,SYSTEM
1350911233.000000,56.000000,0.000000,42,admin
1350911233.000000,23.000000,0.000000,41,admin
1350889811.000000,0,0,2001,SYSTEM
1350889810.000000,0,0,2002,SYSTEM
1350543503.000000,56.000000,0.000000,42,admin
1350543503.000000,23.000000,0.000000,41,admin
1350543503.000000,Test Meter,Test Meter23423234hy3w41,1,admin
1350543412.000000,0,0,2004,SYSTEM
1350543359.000000,0,0,2001,SYSTEM
1350543358.000000,0,0,2002,SYSTEM
1350459220.000000,0,0,2001,SYSTEM
1350459138.000000,0,0,2002,SYSTEM
1350373623.000000,0,0,2001,SYSTEM
1350373620.000000,0,0,2000,SYSTEM
1350370738.000000,0,0,2001,SYSTEM
1350370738.000000,0,0,2002,SYSTEM
1349723473.000000,0,0,2001,SYSTEM
1349723473.000000,0,0,2002,SYSTEM
1349642014.000000,0,0,2001,SYSTEM
1349642014.000000,0,0,2002,SYSTEM
1349633708.000000,0,0,2001,SYSTEM
1349633708.000000,0,0,2002,SYSTEM
1349632228.000000,0,0,2001,SYSTEM
1349632228.000000,0,0,2002,SYSTEM
1349629238.000000,0,0,2001,SYSTEM
1349629237.000000,0,0,2002,SYSTEM
[END]
```

The denotation of each row is shown in Appendix D Report and Event Column Definition.

6.2.9. Report

The following reports that are downloadable from the controller are as listed below.

- Daily report
  - A file is generated on the first day of the month at contract hour.
  - Every day at the expiration of the contract hour, a row is added to this file.
  - Every meter will have its own file
  - In CSV file format
- Monthly report
  - A file is generated on the first day of the year at contract hour
  - On the every first day of the month at the contract hour, a row is added to this file on the first of the next month at the expiration of the contract hour.
  - Every meter will have its own file
  - In CSV file format
- Meter report
  - A file is generated when a change to the flow calculation parameter is made
  - Every meter will have its own file
  - In CSV file format
- Event log
  - If an appropriate event occurs after the first day of the month after 0000hrs, a new file is generated, and any event occurring in that month is logged in this file.

- Every meter will have its own file
- In CSV file format

The format of the column for each file type is listed in Appendix D Report and Event Column Definition.

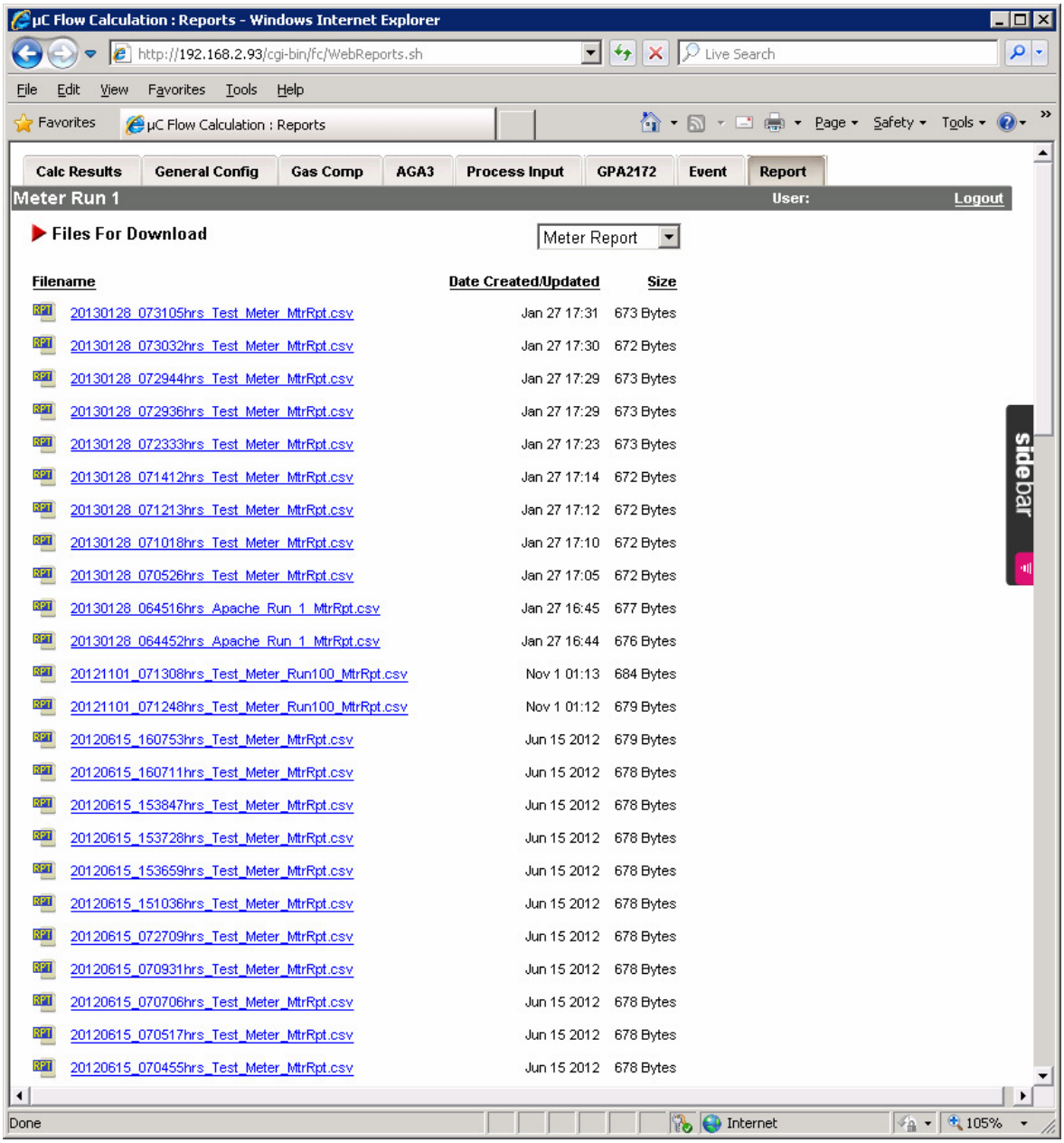
µC Flow Calculation : Reports - Windows Internet Explorer
http://192.168.2.93/cgi-bin/fc/WebReports.sh
File Edit View Favorites Tools Help
Favorites
µC Flow Calculation : Reports
Page Safety Tools
Calc Results
General Config
Gas Comp
AGA3
Process Input
GPA2172
Event
Report
Meter Run 1
User:
Logout
Files For Download
Meter Report
Filename
Date Created/Updated
Size
20130128_073105hrs_Test_Meter_MtrRpt.csv Jan 27 17:31 673 Bytes
20130128_073032hrs_Test_Meter_MtrRpt.csv Jan 27 17:30 672 Bytes
20130128_072944hrs_Test_Meter_MtrRpt.csv Jan 27 17:29 673 Bytes
20130128_072936hrs_Test_Meter_MtrRpt.csv Jan 27 17:29 673 Bytes
20130128_072333hrs_Test_Meter_MtrRpt.csv Jan 27 17:23 673 Bytes
20130128_071412hrs_Test_Meter_MtrRpt.csv Jan 27 17:14 672 Bytes
20130128_071213hrs_Test_Meter_MtrRpt.csv Jan 27 17:12 672 Bytes
20130128_071018hrs_Test_Meter_MtrRpt.csv Jan 27 17:10 672 Bytes
20130128_070526hrs_Test_Meter_MtrRpt.csv Jan 27 17:05 672 Bytes
20130128_064516hrs_Apache_Run_1_MtrRpt.csv Jan 27 16:45 677 Bytes
20130128_064452hrs_Apache_Run_1_MtrRpt.csv Jan 27 16:44 676 Bytes
20121101_071308hrs_Test_Meter_Run100_MtrRpt.csv Nov 1 01:13 684 Bytes
20121101_071248hrs_Test_Meter_Run100_MtrRpt.csv Nov 1 01:12 679 Bytes
20120615_160753hrs_Test_Meter_MtrRpt.csv Jun 15 2012 679 Bytes
20120615_160711hrs_Test_Meter_MtrRpt.csv Jun 15 2012 678 Bytes
20120615_153847hrs_Test_Meter_MtrRpt.csv Jun 15 2012 678 Bytes
20120615_153728hrs_Test_Meter_MtrRpt.csv Jun 15 2012 678 Bytes
20120615_153659hrs_Test_Meter_MtrRpt.csv Jun 15 2012 678 Bytes
20120615_151036hrs_Test_Meter_MtrRpt.csv Jun 15 2012 678 Bytes
20120615_072709hrs_Test_Meter_MtrRpt.csv Jun 15 2012 678 Bytes
20120615_070931hrs_Test_Meter_MtrRpt.csv Jun 15 2012 678 Bytes
20120615_070706hrs_Test_Meter_MtrRpt.csv Jun 15 2012 678 Bytes
20120615_070517hrs_Test_Meter_MtrRpt.csv Jun 15 2012 678 Bytes
20120615_070455hrs_Test_Meter_MtrRpt.csv Jun 15 2012 678 Bytes
sidebar
Done
Internet
105%

Figure 6.2.9A, Report Tab

6.3. Web Interface Security

A layer security is present when the user wants to access the web interface pages (System Configuration or Flow Calculation Configuration). System Configuration and Flow Calculation Configuration maintains its own login session. That is, if the user logins into System Configuration and if the user wants to view the Flow Calculation Configuration, he/she will have login to Flow Calculation Configuration.

Since System Configuration and Flow Calculation Configuration maintain its own login session, when the user logs out of the System Configuration, the login session in Flow Calculation Configuration web interface is not lost. Likewise, if the user logs out of Flow Calculation Configuration, the login session to System Configuration is not lost.

The figure below shows System Configuration login windows.

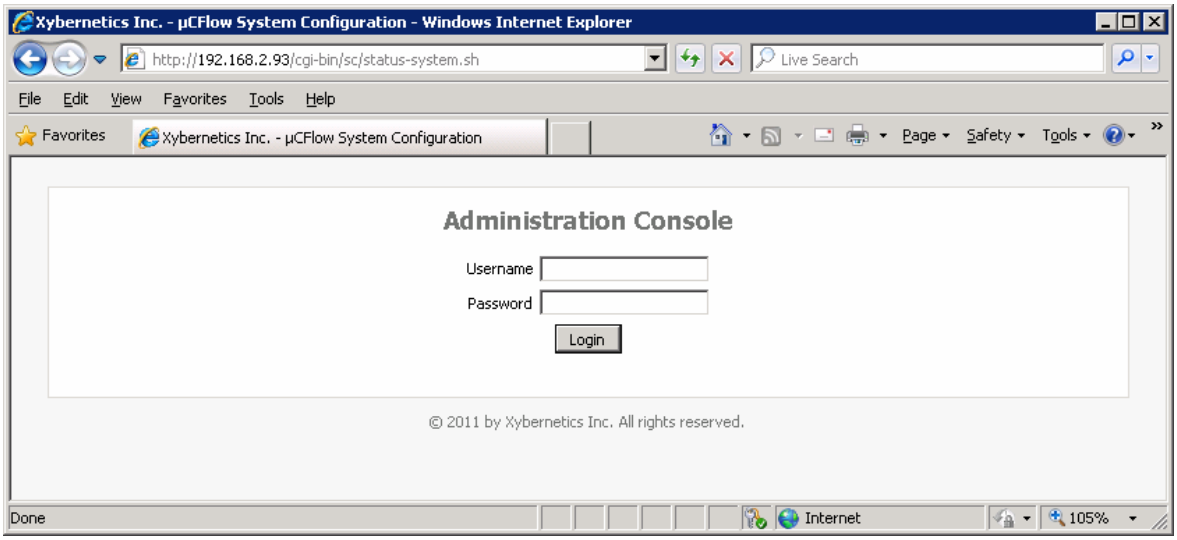

Figure 6.3A, System Configuration Login

7. FLOW CALCULATION FEATURES

This section highlights all function and features that is available in the uCFlowCalc controller.

7.1. Flow Calculations Algorithms

The following algorithms to calculate flow for natural gases are covered in the controller.

- AGA Report Number 3, 1990 (Orifice flow metering)
- AGA Report Number 7, 1985 (Measurement of gas by turbine meter)
- AGA Report Number 8, 1992 (Compressibility factor of natural gas and other related hydrocarbon gases; Detail Characterization Method)
- AGA Report Number 8, 1992 (Compressibility factor of natural gas and other related hydrocarbon gases; Gross Characterization Method 1 and 2)
- AGA Report Number 5, 1985 (Fuel gas energy metering; Gas volume to energy conversion method)
- V-Cone flow calculation (gas and liquid)
- Wafer-Cone flow calculation (gas and liquid)
- AGA Report Number 9, 1998 (Measurement of Gas by Multipath Ultrasonic Meters)
- AGA Report Number 10, 1998 (Speed of Sound in Natural Gas and Other Related hydrocarbon Gases)

The flow calculation selection can be made through web interface or though Modbus communication

7.2. Flow Parameter Load File (.aga)

There are two ways to configure the flow calculation parameter. The conventional way is to use the Flow Calculation web interface and enter every flow parameters. The other way is to use a predefined flow parameter file and upload it into the controller, which essentially speed up configuration time to sites with similar settings.
The flow parameter is a text file which can be easily edited using any text editor if further customisation is required.

To load the flow parameter file go to the Flow Calculation web interface. Select “General Config” tab and upload the file into the controller using the “Config File” textbox. See figure shown below.

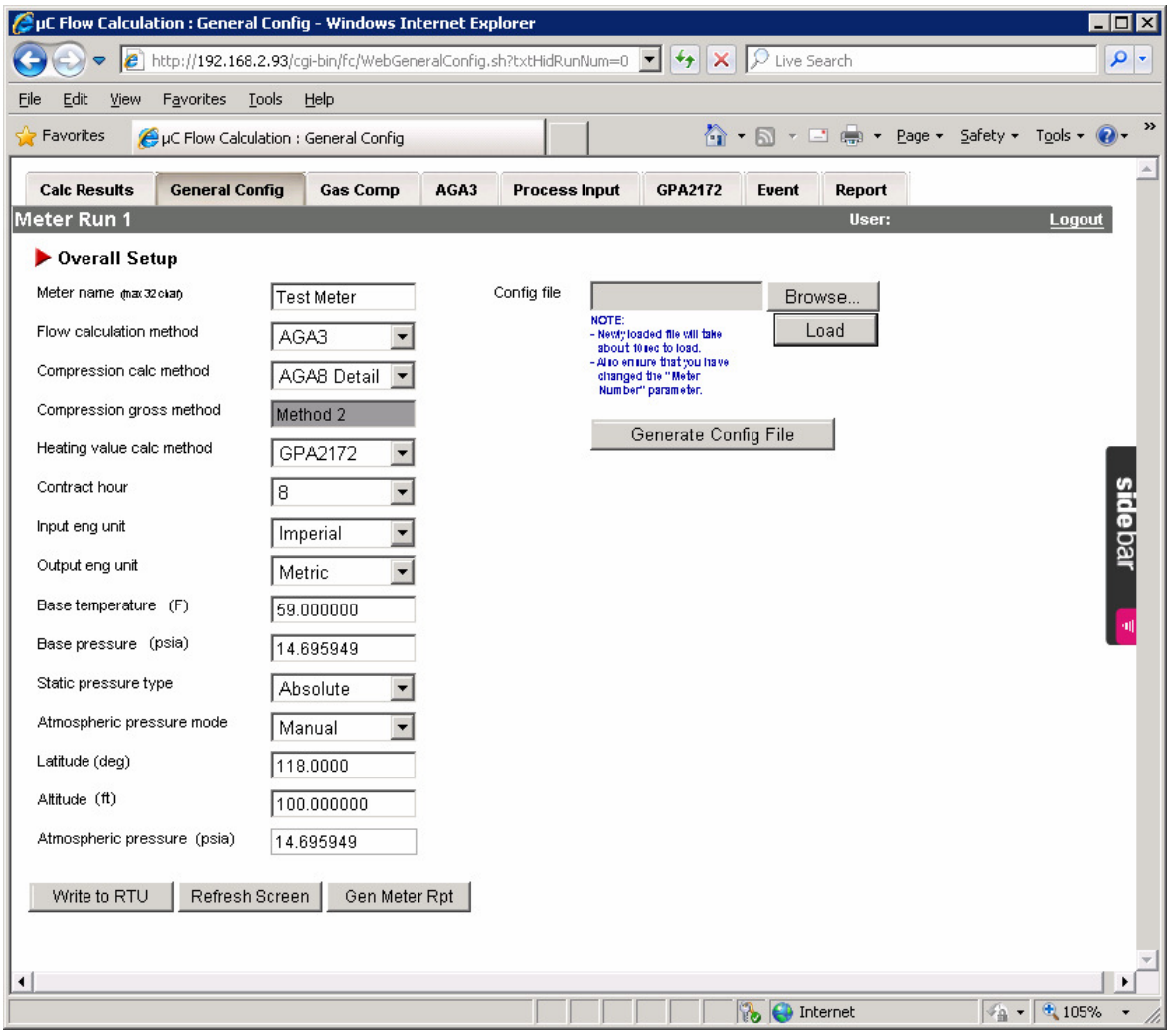

Figure 7.2A, System Configuration Login

Once the flow parameter file is loaded, it will require 30 seconds for the program to verify and upload the new configuration into the currently running flow calculation. The user is required to refresh (by pressing F5 or the “Refresh” button) the web page to view the newly uploaded flow parameters in the web interface.

Power cycle of the controller is not required to apply these changes.

A sample of the flow parameter load file can be found in Appendix A of this document. Here are the characteristics of the file.

- [config] denotes section header and it should **not** be edited
- The delimiter is a pound character "#"
- Anything before the delimiter is title header and it should **not** be edited. The title header gives the user some insight of what value they are configuring. If a fixed value is expected from the use (for example "Flow calculation algorithm selection"), the title header provides options that are available for the user.
- Anything after the delimiter is the value. These values can be edited as per user requirements and preference. It is to be noted that some value can be an integer and other can be real numbers.
- The order of the flow calculation parameter file should not be changed. When the flow calculation program reads the configuration file it is, expecting the input values in that order as shown in Appendix A. Changing the order will result in inaccurate flow calculation and potentially program to crash due to numeric over flow (as integer was expected and a floating point was provided)
- "Meter Number" parameter must be changed according to which meter run this ".aga" file is for. For example, if the configuration file is for meter run number 8, "Meter Number" parameter in the file must be changed to "`Meter Number#8`" before loading the file to the controller through the webpage. The valid entry is an integer number from 1 to 10.
- The data get loaded every 10 seconds. That is to say that if you load the configuration file using the web page, the program will take as long as 10 seconds before loading it to the runtime flow calculation parameters.

A sample of the Flow Parameters Load File can be found in Appendix A or in the following Xybernetics webpage under "Download" tab.

http://www.xybernetics.com/solutions-uCFlowCal.html

7.3. Data Persistence and Restore

When ever a user makes any changes to the flow calculation parameters, the complete flow parameter configurations for that particular meter run is saved to a persistence file. During the event of power loss or if the user decides to reset the controller, the persistence file helps in reinstating the previous flow parameter before the power loss or user reset.

7.4. Error Messages

This section covers error messages that are issued by the flow calculation program and what is its significance.

- AGA8 Detail : Gas composition not within range (0.999995<=GC<=1.000005)
    a. This error message is issued when the total gas composition does not adds to greater than or equal to 0.999995 and less than or equal to 1.000005
    b. Gas composition is required to be reviewed again to rectify this issue
    c. This message is represented as -1 in Modbus register. For Modbus register number refer to Appendix B
- AGA3 : Incorrect static tap location
- AGA8 : Flow temp and/or static pressure is out of range (-200<=T<=760 & 0<=P<=40000)
- AGA3 : Pressure ratio out of range

- AGA3 : Temperature ratio out of range
- AGA3 : Division by zero (check diameter and specific gravity)
- AGA7 : Division by zero (check k factor and time span)
- Cone : Division by zero (check diameter and specific gravity)
- Invalid calculation selection
- Invalid atmospheric pressure selection
- Invalid specific gravity selection
- AGA3 : Invalid orifice plate material
- AGA3 : Invalid pipe material
- AGA3 : Invalid static pressure tap location
- Cone : Invalid pipe material
- Cone : Invalid cone material
- Cone : Invalid state of fluid
- AGA5 : Division by zero
- AGA8 DCM : Division by zero
- AGA3 : Orifice plate diameter >= pipe diameter
- Cone : Cone diameter >= pipe diameter
- AGA8 : Invalid compressibility calculation selection
- AGA8 Gross : Heating value <= 0.00
- AGA8 Gross : Ref temperature for heating value <= zero
- AGA8 Gross : N2, CO2, H2 and/or CO is zero
- AGA8 Gross : N2, CO2, H2 and/or CO is < zero
- AGA8 Gross : Specific gravity <= zero
- AGA8 Gross : Ref temperature for specific gravity <= zero
- AGA8 Gross : Ref pressure for specific gravity <= zero
- AGA3 : Flowrate is negative
- Controller date and time has not been updated or report file cannot be created/appended/open.

8. FLOW CALCULATION INPUT AND OUTPUT VALUES

This section discusses what values can be input to the controller and what will be the output from the controller.

8.1. Input Values

The following are the required input values required for the AGA program to function properly.

8.2. Input Value Ranges

The flow calculation equation for medium type has a validity range, of which it directly dictates it accuracy. If the input value(s) starts to go off the specified range, the result of the AGA published equations starts to deteriorate and enter a section of the trend call uncertainty value range.
The sections bellow outlines the range of each equation before the calculated value starts to get into the uncertainty range.

8.2.1. AGA Report Number 3 (Orifice flow metering) Input Value Ranges

The followings are the conditions that must satisfy before implementing AGA3 calculations. Any input values out of this range will fall under uncertainty condition.

8.2.1.1. Linear Coefficient of Thermal Expansion

- Constant for SUS304/316 is valid for temperature range from -100°F to 300°F (-73.33°C to 148°C)
- Constant for Monel is valid for temperature range from -100°F to 300°F (-73.33°C to 148°C)
- Constant for Carbon Steel is valid for temperature range from -7°F to 154°F (-21°C to 67.77°C)
- Reference temperature is assumed to be 68°F (see AGA3, Part3, pg8)

8.2.1.2. Upstream/Downstream Expansion Factor

- The pressure ratio (diff. pressure/abs static at upstream) must be from 0 to 0.2
- The pressure ratio (abs static at downstream/abs static at upstream) must be from 0.8 to 1.0
- Beta ratio (orifice diameter at flowing temp/meter diameter at flowing temp) must be from 0.10 to 0.75
- Also meter and orifice plate temperature range must be met (see section 4.1.1)

8.2.1.3. Coefficient of Discharge

- Initial coefficient of discharge is assumed to be 0.06 (as per AGA3 Part2, pg 57, recommendation).

8.2.1.4. Reynolds Number

- Base temperature is assumed to be 60°F, 519.67R (see AGA3, Part3, pg11)
- Base pressure is assumed to be 14.73psi (see AGA3, Part3, pg11)
- Compressibility of air at base pressure is assumed to be 0.999590 (see AGA3, Part3, pg11)

8.2.2. AGA Report Number 8 (Compressibility) Input Value Ranges

The followings are the conditions that must satisfy before implementing AGA8 calculations. Any input values out of this range will fall under uncertainty condition.

8.2.2.1. Pressures

Pressure must range between 0 to 40000psia.

8.2.2.2. Temperature

Temperature must range between -200°F to 760°F.

8.2.2.3. Gas Composition

- Methane composition fraction must be within 0.45 to 1.00.
- Nitrogen composition fraction must be within 0.00 to 0.50.
- Carbon dioxide composition fraction must be within 0.00 to 0.30.
- Ethane composition fraction must be within 0.00 to 0.10.
- Propane composition fraction must be within 0.00 to 0.04.
- Water composition fraction must be within 0.00 to 0.0005.
- Hydrogen sulphide composition fraction must be within 0.00 to 0.0002.
- Hydrogen composition fraction must be within 0.00 to 0.10.
- Carbon monoxide composition fraction must be within 0.00 to 0.03.
- Oxygen composition fraction must be within 0.00 to 1.00.
- i-Butane composition fraction must be within 0.00 to 0.01.
- n-Butane composition fraction must be within 0.00 to 0.01.
- i-Pentane composition fraction must be within 0.00 to 0.003.
- n-Pentane composition fraction must be within 0.00 to 0.003.

- n-Hexane composition fraction must be within 0.00 to 0.002.
- n-Heptane composition fraction must be within 0.00 to 1.00.
- n-Octane composition fraction must be within 0.00 to 1.00.
- n-Nonane composition fraction must be within 0.00 to 1.00.
- n-Decane composition fraction must be within 0.00 to 1.00.
- Helium composition fraction must be within 0.00 to 0.002.
- Argon composition fraction must be within 0.00 to 1.00.

8.3. AGA Report Number 7 (Turbine metering) Input Value Ranges

User specified “Unit Time” will dictate the rate of flow unit. For example, if the “Unit Time” is in hours, the calculated flow will be in ft3/hr. Or if the “Unit Time” is in minutes, the calculated flow will be in ft3/min.

8.4. AGA Report Number 5 (Fuel gas energy metering) Input Value Ranges

4.4.1 General equation
Gas volume to energy conversion only applies to volume units under a pressure of 14.73psi and 60°F
4.4.2 Energy volume ratio
a) Energy-volume ratio is at 14.73psi and 60°F
b) AGA5 uses volumetric flow equation to calculate the gas energy. The other way to calculate gas energy is using mass flowrate (not in this program).

8.5. Wafer Cone (Gas and liquid) Input Value Ranges

The followings are the conditions that must satisfy before implementing wafer cone calculation. Any input values out of this range will fall under uncertainty condition.

8.5.1. Linear Coefficient of Thermal Expansion

- Constant for SUS304/316 is valid for temperature range from -100°F to 300°F (-73.33°C to 148°C)
- Constant for Monel is valid for temperature range from -100°F to 300°F (-73.33°C to 148°C)
- Constant for Carbon Steel is valid for temperature range from -7°F to 154°F (-21°C to 67.77°C)
- Reference temperature is assumed to be 68°F (see AGA3, Part3, pg8)
- If operating temperature is <560 Rankin (<100F, <38C), material thermal expansion factor (Fa) will be excluded from the calculation. That is, all this ranges will not apply at all.

8.6. V- Cone (Gas and liquid) Input Value Ranges

The followings are the conditions that must satisfy before implementing v-cone calculation. Any input values out of this range will fall under uncertainty condition.

8.6.1. Linear Coefficient of Thermal Expansion

- Constant for SUS304/316 is valid for temperature range from -100°F to 300°F (-73.33°C to 148°C)
- Constant for Monel is valid for temperature range from -100°F to 300°F (-73.33°C to 148°C)
- Constant for Carbon Steel is valid for temperature range from -7°F to 154°F (-21°C to 67.77°C)
- Reference temperature is assumed to be 68°F (see AGA3, Part3, pg8)

- If operating temperature is <560 Rankin (<100F, <38C), material thermal expansion factor (Fa) will be excluded from the calculation. That is, all this ranges will not apply at all.

A. APPENDIX – FLOW PARAMETER LOAD FILE (SAMPLE)

```
[config]
Meter number#1
Meter name#Test Meter Run100
Flow calculation algorithm selection (AGA3=1, AGA7=2, VCone=3, WaferCone=4)#1
Compression calculation algorithm selection (AGA8 Detail=1, AGA8 Gross=2)#1
AGA8 Gross method selection (Method 1=1, Method 2=2)#1
Heating value calculation method (AGA5=1, GPA2172=2)#2
Atmospheric pressure calculation selection (Calculated=1, Manual=2)#2
Specific gravity calculation selection (Calculated=1, Manual=2)#2
Correction factor for AGA 3 (0.0000 to 1.0000 inclusive)#1
Contract hour#8
Input parameter engineering unit (metric=1,imperial=2)#2
Output parameter engineering unit (metric=1,imperial=2)#2
Methane, CH4#0.7068
Nitrogen, N2#0.0184
Carbon dioxide, C02#0.0000
Ethane, C2H6#0.1414
Propane, C3H8#0.0674
Water, H2O#0.0000
Hydrogen sulphide, H2S#0.0260
Hydrogen, H2#0.0000
Carbon monoxide, CO#0.0000
Oxygen, O2#0.0000
i-Butane, IC4H10#0.0081
n-Butane, NC4H10#0.0190
i-Pentane, IC5H12#0.0038
n-Pentane, NC5H12#0.0043
n-Hexane, C6H14#0.0026
n-Heptane, C7H16#0.0022
n-Octane, C8H18#0.0000
n-Nonane, C9H20#0.0000
n-Decane, C10H22#0.0000
Helium, He#0.0000
Argon, Ar#0.0000
Atmospheric pressure in psia#13.5
Orifice plate and tube diameter measurement reference temperature in F#68.00
Static pressure type (absolute=1,gauge=2)#1
Differential pressure cutoff in inH2O#2.0
Upstream static pressure deadband in psia#2.0
Differential pressure deadband in inH2O#3.0
Flow temperature deadband in °F#4.0
Latitude (degrees)#118
Latitude (minutes)#23
Latitude (seconds)#56
Altitude in ft#100.0
Base temperature in °F#59.0
Base pressure in psia#14.695948804
Orifice diameter at reference temperature in inches#0.375
Meter diameter at reference temperature#2.0618
Orifice plate material (stainless steel=1,monel=2,carbon steel=3)#1
Meter tube material (stainless steel=1,monel=2,carbon steel=3)#3
Static pressure tap location (upstream=1,downstream=2)#1
Isentropic expansion, as per EUB Dir 17#1.3
Viscosity in lbm/ftsec#0.0000068997766652
Specific gravity#0.7792
AGA7, K, pulses per cubic foot#0.0
AGA7, Unit time#0.0
Cone, Pipe inside diameter (inches)#0.0
Cone, Cone diameter (inches)#0.0
Cone, Flowmeter coefficient (CD)#0.0
Cone, Pipe material (stainless steel=1,monel=2,carbon steel=3)#0
Cone, Cone material (stainless steel=1,monel=2,carbon steel=3)#0
Cone, Reference specific gravity at 60°F, 14.696psia#0.0
Cone, State of fluid (liquid=1, gases and vapours=0)#0
AGA8 Gross, Gross calorific heating value for gas mixture in BTU/ft³#1034.85
AGA8 Gross, Reference temperature for heating value in °F#60.0
AGA8 Gross, Reference temperature for molar density in °F#60.0
AGA8 Gross, Reference temperature for relative density in F#60.0
AGA8 Gross, Reference pressure for molar density in psi#14.73
AGA8 Gross, Reference pressure for relative density in psi#14.73
AGA9 Average velocity in ft/hr#0.0
AGA9 Low-flow velocity threshold in ft/hr#0.0
AGA9 Enable CPSM (0=off, 1=on)#0
AGA9 Enable CTSM (0=off, 1=on)#0
```

```
AGA9 Enable profile correction factor (0=off, 1=on)#0
AGA9 CPSM state (Calculated=1, Manual=2)#1
AGA9 CTSM state (Calculated=1, Manual=2)#1
AGA9 Profile correction factor state (Calculated=1, Manual=2)#1
AGA9 Pipe outside diameter in ft#0.0
AGA9 Pipe inside diameter in ft#0.0
AGA9 Poisson's ratio#0.0
AGA9 Young's modulus of elasticity in psia#0.0
AGA9 Reference pressure in psia#0.0
AGA9 Reference temperature in °F#0.0
AGA9 Pipe linear expansion coefficient due to temperature in/in-°F#0.0
AGA9 Wall roughness in ft#0.0
AGA9 Path factor (0.94=Juniorsonic, 1.00=Seniorsonic)#0.0
AGA9 Dynamic viscousity in lbm/ft.sec#0.0
AGA9 Manual CPSM entry#0.0
AGA9 Manual CTSM entry#0.0
AGA9 Manual profile correction factor entry#0.0
GPA2172 Base temperature for density in °F#60.0
GPA2172 Base temperature for heating value in °F#60.0
Put static pressure in debug mode (enable=1,disable=2)#2
Put differential pressure in debug mode (enable=1,disable=2)#2
Put flow temperature in debug mode (enable=1,disable=2)#2
Mock static pressure (must be in debug mode)#408.73
Mock differential pressure (must be in debug mode)#40.9897
Mock flow temperature (must be in debug mode)#134.6
Static pressure calibration value, high high in psi#800.0
Static pressure calibration value, high in psi#600.0
Static pressure calibration value, low in psi#200.0
Static pressure calibration value, low low in psi#100.0
Differential pressure calibration value, high high in inH2O#25.0
Differential pressure calibration value, high in inH2O#20.0
Differential pressure calibration value, low in inH2O#8.0
Differential pressure calibration value, low low in inH2O#5.0
Flow temperature calibration value, high high in °F#400.0
Flow temperature calibration value, high in °F#380.0
Flow temperature calibration value, low in °F#100.0
Flow temperature calibration value, low low in °F#80.0
```

Note:

- "Meter Number" parameter must be changed according to where this aga file is to be loaded. For example, it is for meter run number 8, "Meter Number" parameter in the file must be changed to "`Meter Number#8`" before loading the file to the controller through the webpage.
- The data get loaded every 10 seconds. That is to say that if you load the configuration file using the web page, the program will take as long as 10 seconds before loading it to the runtime flow calculation parameters.

B. APPENDIX –MODBUS REGISTER ADDRESSES FOR FULL DEVICE POLL TYPE

- **Input Values**
  The table below gives a detail overview of all input values for the controller. The Modbus Offset Register is a number that is to be added to the Start Modbus Register defined in the System Configuration web interface. For example, if the Start Register defined in the System Configuration is 810, the Modbus register address of "Flow Calculation Algorithm" will be 40811. It is to be noted that integer refers to 16 bit number and float is a 32 bit number. Therefore, the Modbus address of Methane would be 40812 and Nitrogen would be 40814.
  The input values engineering unit is in imperial (as shown in table below) as all calculations are done in imperial; however, the user has the option of having the input value as metric. This engineering unit change can be done in Flow Calculation web interface.

Modbus Register Offset	Description	Eng. Unit	Datatype	Note
1	Flow calculation algorithm selection	-	integer	AGA3=1 AGA7=2 V-Cone=3 Wafer Cone=4
2	Compression calculation algorithm selection	-	integer	AGA8 Detail=1 AGA8 Gross=2
3	AGA8 Gross method selection	-	integer	Method 1=1 Method 2=2
4	Heating value calculation method	-	integer	AGA5=1 GPA2172=2
5	Atmospheric pressure calculation selection	-	integer	Calculated=1 Manual=2
6	Specific gravity calculation selection	-	integer	Calculated=1 Manual=2
7	Correction factor for AGA 3 (0.0000 to 1.0000 inclusive)	-	float	
9	Contract hour	hour	integer	
10	Input parameter engineering unit	-	integer	Metric=1 Imperial=2

11	Output parameter engineering unit	-	integer	metric=1 imperial=2
12	Methane, CH4	fraction 0 to 1	float	
14	Nitrogen, N2	fraction 0 to 1	float	
16	Carbon dioxide, C02	fraction 0 to 1	float	
18	Ethane, C2H6	fraction 0 to 1	float	
20	Propane, C3H8	fraction 0 to 1	float	
22	Water, H2O	fraction 0 to 1	float	
24	Hydrogen sulphide, H2S	fraction 0 to 1	float	
26	Hydrogen, H2	fraction 0 to 1	float	
28	Carbon monoxide, CO	fraction 0 to 1	float	
30	Oxygen, O2	fraction 0 to 1	float	
32	i-Butane, IC4H10	fraction 0 to 1	float	
34	n-Butane, NC4H10	fraction 0 to 1	float	
36	i-Pentane, IC5H12	fraction 0 to 1	float	
38	n-Pentane, NC5H12	fraction 0 to 1	float	
40	n-Hexane, C6H14	fraction 0 to 1	float	
42	n-Heptane, C7H16	fraction 0 to 1	float	
44	n-Octane, C8H18	fraction 0 to 1	float	
46	n-Nonane, C9H20	fraction 0 to 1	float	
48	n-Decane, C10H22	fraction 0 to 1	float	
50	Helium, He	fraction 0 to 1	float	
52	Argon, Ar	fraction 0 to 1	float	
54	Atmospheric pressure	psia	float	
56	Orifice plate and tube diameter measurement reference temperature	°F	float	
58	Static pressure type	-	integer	Absolute=1 Gauge=2
59	Differential pressure cutoff	inH2O	float	
61	Upstream static pressure deadband	psia	float	
63	Differential pressure deadband	inH2O	float	

65	Flow temperature deadband	°F	float	
67	Latitude	degrees	float	
69	Latitude	minutes	float	
71	Latitude	seconds	float	
73	Altitude	ft	float	
75	Base temperature	°F	float	
77	Base pressure	psia	float	
79	Orifice diameter at reference temperature	in	float	
81	Meter diameter at reference temperature	in	float	
83	Orifice plate material	-	integer	Stainless steel=1 Monel=2 Carbon steel=3
84	Meter tube material	-	integer	Stainless steel=1 Monel=2 Carbon steel=3
85	Static pressure tap location	-	integer	Upstream=1 Downstream=2
86	Isentropic expansion, as per API AGA Report 3	-	float	
88	Viscosity	lnm/ft.sec	float	
90	Specific gravity	-	float	
92	AGA7, K factor	pulse/ft³	float	
94	AGA7, Unit time	see note	float	
96	Cone, Pipe inside diameter	in	float	
98	Cone, Cone diameter	in	float	
100	Cone, Flowmeter coefficient (CD)	-	float	
102	Cone, Pipe material	-	integer	Stainless steel=1 Monel=2 Carbon steel=3

103	Cone, Cone material	-	integer	Stainless steel=1 Monel=2 Carbon steel=3
104	Cone, Reference specific gravity at 60°F, 14.696psia	-	float	
106	Cone, State of fluid	-	integer	liquid=1 gases and vapors=0
107	AGA8 Gross, Gross calorific heating value for gas mixture	BTU/ft³	float	
109	AGA8 Gross, Reference temperature for heating value	°F	float	
111	AGA8 Gross, Reference temperature for molar density	°F	float	
113	AGA8 Gross, Reference temperature for relative density	°F	float	
115	AGA8 Gross, Reference pressure for molar density	psi	float	
117	AGA8 Gross, Reference pressure for relative density	psi	float	
119	AGA9 Average velocity	ft/hr	float	
121	AGA9 Low-flow velocity threshold	ft/hr	float	To acquire full flow calculation parameters from the controller, 2 Modbus polls is required. From this register 2nd poll starts.
123	AGA9 Enable CPSM	-	integer	Off=0 On=1
124	AGA9 Enable CTSM	-	integer	Off=0 On=1
125	AGA9 Enable profile correction factor	-	integer	Off=0 On=1
126	AGA9 CPSM state	-	integer	Calculated=1 Manual=2
127	AGA9 CTSM state	-	integer	Calculated=1 Manual=2
128	AGA9 Profile correction factor state	-	integer	Calculated=1 Manual=2
129	AGA9 Pipe outside diameter	ft	float	

132	AGA9 Pipe inside diameter	ft	float	
133	AGA9 Poisson's ratio	-	float	
135	AGA9 Young's modulus of elasticity	psia	float	
137	AGA9 Reference pressure	psia	float	
139	AGA9 Reference temperature	°F	float	
141	AGA9 Pipe linear expansion coefficient due to temperature	in/in.°F	float	
143	AGA9 Wall roughness	ft	float	
145	AGA9 Path factor	-	float	Junior sonic=0.94 Senior sonic=1.00
147	AGA9 Dynamic viscosity	lbm/ft.sec	float	
149	AGA9 Manual CPSM entry	-	float	
151	AGA9 Manual CTSM entry	-	float	
153	AGA9 Manual profile correction factor entry	-	float	
155	GPA2172 Base temperature for density	°F	float	
157	GPA2172 Base temperature for heating value	°F	float	
159	Put static pressure in debug mode	-	integer	Enable=1 Disable=2
160	Put differential pressure in debug mode	-	integer	Enable=1 Disable=2
161	Put flow temperature in debug mode	-	integer	Enable=1 Disable=2
162	Mock static pressure	psia	float	Must be in debug mode
164	Mock differential pressure	inH2o	float	Must be in debug mode
166	Mock flow temperature	°F	float	Must be in debug mode
168	Static pressure calibration value, high high	psia	float	
170	Static pressure calibration value, high	psia	float	
173	Static pressure calibration value, low	psia	float	
174	Static pressure calibration value, low low	psia	float	
176	Differential pressure calibration value, high high	inH2o	float	
178	Differential pressure calibration value, high	inH2o	float	

180	Differential pressure calibration value, low	inH2o	float	
182	Differential pressure calibration value, low low	inH2o	float	
184	Flow temperature calibration value, high high	°F	float	
186	Flow temperature calibration value, high	°F	float	
188	Flow temperature calibration value, low	°F	float	
190	Flow temperature calibration value, low low	°F	float	

- **Output Values**
  The table below gives a detail overview of all output values from the controller. The Modbus Offset Register is a number that is to be added to the Start Modbus Register defined in the System Configuration web interface. For example, if the Start Register defined in the System Configuration is 810, the Modbus register address of "Compressibility at base condition" will be 40810+192 = 41002. It is to be noted that floating point is a 32 bit number and therefore requiring 2 Modbus registers.
  The output values engineering unit is in imperial (as shown in table below) as all calculations are done in imperial; however, the user has the option of having the output value in metric. This engineering unit change can be done in Flow Calculation web interface.

Modbus Register Offset	Description	Eng. Unit	Datatype	Note
192	Compressibility at base condition	-	float	
194	Molar density at base condition	moles/dm³	float	
196	Mass density at base condition	kg/m³	float	
198	Compressibility at flowing condition	-	float	
200	Molar density at flowing condition	moles/dm³	float	
202	Mass density at flowing condition	kg/m³	float	
204	AGA3 calculated flowrate	ft³/hr	float	
206	AGA3 calculated flowrate	mmscfd	float	
208	AGA7 calculated flowrate	ft³/xxx (Input AGA7, Unit time)	float	
210	AGA5 calculated energy	BTU/min	float	
212	Wafer and V-cone flowrate	ft³/sec	float	
214	Calculated specific gravity	-	float	

216	Heating value	BTU/ft³	float	
208	Calculated/User input atmospheric pressure	psi	float	
220	AGA10 calculated speed of sound	m/s	float	
222	AGA9 calculated flowrate	ft³/hr	float	
224	GPA2172 Gross heating value	BTU/lb	float	
226	GPA2172 Gross heating value	BTU/Ideal CF	float	
228	GPA2172 Gross heating value	BTU/Real CF	float	
230	Flow calculation duration	second	long	
232	Error code	-	integer	-1: AGA8 Detail : Gas composition not within range (0.999995<=GC<=1.000005) -2: AGA3 : Incorrect static tap location -3: AGA8 : Flow temp and/or sp is out of range (-200<=T<=760 & 0<=P<=40000) -4: AGA3 : Pressure ratio out of range -5: AGA3 : Temperature ratio out of range -6: AGA3 : Division by zero (check diameter and specific gravity) -7: AGA7 : Division by zero (check k factor and time span) -8: Cone : Division by zero

				(check diameter and specific gravity) -9: Invalid calc selection -10: Invalid atmospheric pressure selection -11: Invalid specific gravity selection -12: AGA3 : Invalid orifice plate material -13: AGA3 : Invalid pipe material -14: AGA3 : Invalid static pressure tap location -15: Cone : Invalid pipe material -16: Cone : Invalid cone material -17: Cone : Invalid state of fluid -18: AGA5 : Division by zero -19: AGA8 DCM : Division by zero -20: AGA3 : Orifice plate diameter >= pipe diameter

				-21: Cone : Cone diameter >= pipe diameter -22: AGA8 : Invalid compressibility calculation selection -23: AGA8 Gross : Heating value <= 0.00 -24: AGA8 Gross : Ref temperature for heating value <= zero -23: AGA8 Gross : N2, CO2, H2 and/or CO is zero -26: AGA8 Gross : N2, CO2, H2 and/or CO is < zero -27: AGA8 Gross : Specific gravity <= zero -28: AGA8 Gross : Ref temperature for specific gravity <= zero -29: AGA8 Gross : Ref pressure for specific gravity <= zero -30: AGA3 : Flowrate is negative -31: Controller date and time

				has not been updated or report file cannot be created/appended/open.
233	AGA 8 last calculation time	Unix time	long	
235	AGA 3 last calculation time	Unix time	long	
237	AGA 7 last calculation time	Unix time	long	
239	Cone last calculation time	Unix time	long	

- **Reports Values**
  The table below gives a detail overview of all reporting values from and to the controller.

Modbus Register Offset	Description	Eng. Unit	Datatype	Note
241	Today - Hourly average static pressure	psia	float	
243	Today - Hourly average differential pressure	inH2O	float	
245	Today - Hourly average flow temperature	°F	float	
247	Today - Hourly average flowrate	mmscfd	float	
249	Today - Accumulated flow	mmscf	float	
251	Today - Accumulated flow (corrected by user)	mmscf	float	
253	Yesterday - Daily average static pressure	psia	float	
255	Yesterday - Daily average differential pressure	inH2O	float	
257	Yesterday - Daily average flow temperature	°F	float	
259	Yesterday - Daily average flowrate	mmscfd	float	
261	Yesterday - Accumulated flow	mmscf	float	
263	Yesterday - Accumulated flow (corrected by user)	mmscf	float	
265	Yesterday - Total flow time	seconds	float	
267	Current month - Accumulated flow	mmscf	float	
269	Current month - Accumulated flow time	seconds	float	
271	Current month - Accumulated flow (corrected by user)	mmscf	float	
273	Previous month - Accumulated flow	mmscf	float	

275	Previous month - Accumulated flow time	seconds	float	
277	Previous month - Accumulated flow (corrected by user)	mmscf	float	
279	Today - Corrected total flow flag	-	integer	Correction=1 No correction=2
280	Yesterday - Corrected total flow	-	integer	Correction=1 No correction=2
281	Current month - Corrected total flow	-	integer	Correction=1 No correction=2
282	Previous month - Corrected total flow flag	-	integer	Correction=1 No correction=2
283	Report trigger - Unix time of next month report	-	long	
285	Contract hr trigger - Unix time of next contract hour	-	long	
287	Hourly trigger - Unix time of next hour	-	long	

- **System Date and Time**
  The table below is a list of Modbus table for system time and date; read and write registers.

Modbus Register Offset	Description	Eng. Unit	Datatype	Note
289	Current controller time (read)	Unix time	long	
291	Current hour (read)	hour	integer	
292	Current minute (read)	min	integer	
293	Current second (read)	second	integer	
294	Current day (read)	day	integer	
295	Current month (read)	month	integer	
296	Current year (read)	year	integer	
297	Current controller time (read)	Unix time	long	
299	Current hour (write)	hour	integer	Write current hour to controller
300	Current minute (write)	min	integer	Write current minute to controller
301	Current second (write)	second	integer	Write current second to controller

302	Current day (write)	day	integer	Write current day to controller
303	Current month (write)	month	integer	Write current month to controller
304	Current year (write)	year	integer	Write current year to controller

- **Instantaneous Values**
  The table below highlights Modbus registers for all instantaneous value for flow calculations.

Modbus Register Offset	Description	Eng. Unit	Datatype	Note
305	Instantaneous static pressure	psia	float	
307	Instantaneous differential pressure	inH2O	float	
309	Instantaneous flow temperature	°F	float	
311	Instantaneous turbine frequency	Hz	float	

- **Trigger Values**
  The table below gives a detail overview of all triggering values from and to the controller. The Modbus Offset Register is a number that is to be added to the Start Modbus Register defined in the System Configuration web interface. For example, if the Start Register defined in the System Configuration is 810, the Modbus register address of “Flow Calculation Duration” will be 40810+220 = 41030. It is to be noted that floating point is a 32 bit number and therefore requiring 2 Modbus registers, and an integer is a 16 bit number requiring 1 Modbus register.

Modbus Register Offset	Description	Eng. Unit	Datatype	Note
313	Trigger flow calculation	-	integer	
314	Command from RTU to read from controller	-	integer	
315	Command from RTU to write to controller	-	integer	
316	Command to generate meter report	-	integer	
317	Command to write to persistence file	-	integer	
318	Command to update date and time	-	integer	

- **RTU/PLC Communication Status**

The table below summaries the Modbus table for RTU/PLC communication status.

Modbus Register Offset	Description	Eng. Unit	Datatype	Note
319	RTU/PLC last communication time calculation time	Unix time	long	
321	Modbus slave connection status	-	integer	Modbus slave is connected=1 Modbus slave disconnected=0

Note

- All units shown in the tables are in imperial. In order to change the unit to matrix, change the “Input parameter engineering unit” and/or “Input parameter engineering unit” appropriately.
- Integers are 16 bit number
- Float and long is a 32 bit number

C. APPENDIX – EVENT LOG CODE

This appendix highlights the Event Log Code.

Event Log Code	Event log denotation
1	Meter name changed
2	Flow calculation algorithm selection (AGA3=1, AGA7=2, VCone=3, WaferCone=4) changed
3	Compression calculation algorithm selection (AGA8 Detail=1, AGA8 Gross=2) changed
4	AGA8 Gross method selection (Method 1=1, Method 2=2) changed
5	Heating value calculation method (AGA5=1, GPA2172=2) changed
6	Atmospheric pressure calculation selection (Calculated=1, Manual=2) changed
7	Specific gravity calculation selection (Calculated=1, Manual=2) changed
8	Correction factor for AGA 3 (0.0000 to 1.0000 inclusive) changed
9	Contract hour changed
10	Input parameter engineering unit (metric=1,imperial=2) changed
11	Output parameter engineering unit (metric=1,imperial=2) changed
12	Methane, CH4 changed
13	Nitrogen, N2 changed
14	Carbon dioxide, C02 changed
15	Ethane, C2H6 changed
16	Propane, C3H8 changed
17	Water, H2O changed
18	Hydrogen sulphide, H2S changed
19	Hydrogen, H2 changed
20	Carbon monoxide, CO changed
21	Oxygen, O2 changed
22	i-Butane, IC4H10 changed
23	n-Butane, NC4H10 changed
24	i-Pentane, IC5H12 changed
25	n-Pentane, NC5H12 changed
26	n-Hexane, C6H14 changed
27	n-Heptane, C7H16 changed
28	n-Octane, C8H18 changed
29	n-Nonane, C9H20 changed
30	n-Decane, C10H22 changed
31	Helium, He changed
32	Argon, Ar changed
33	Atmospheric pressure changed
34	Orifice plate and tube diameter measurement reference temperature in deg F changed
35	Static pressure type (absolute=1,gauge=2) changed
36	Differential pressure cutoff changed
37	Upstream static pressure deadband changed
38	Differential pressure deadband changed
39	Flow temperature deadband changed
40	Latitude (degrees) changed
41	Latitude (minutes) changed
42	Latitude (seconds) changed
43	Altitude changed

44	Base temperature changed
45	Base pressure changed
46	Orifice diameter at reference temperature changed
47	Meter diameter at reference temperature changed
48	Orifice plate material (stainless steel=1,monel=2,carbon steel=3) changed
49	Meter tube material (stainless steel=1,monel=2,carbon steel=3) changed
50	Static pressure tap location (upstream=1,downstream=2) changed
51	Isentropic expansion changed
52	Viscosity changed
53	Specific gravity changed
54	AGA7, k-factor changed
55	AGA7, unit time changed
56	Cone, pipe inside diameter changed
57	Cone, cone diameter changed
58	Cone, flowmeter coefficient (CD) changed
59	Cone, pipe material (stainless steel=1,monel=2,carbon steel=3) changed
60	Cone, cone material (stainless steel=1,monel=2,carbon steel=3) changed
61	Cone, reference specific gravity at 60F, 14.696psia changed
62	Cone, state of fluid (liquid=1, gases and vapours=0) changed
63	AGA8 Gross, gross calorific heating value for gas mixture in changed
64	AGA8 Gross, reference temperature for heating value changed
65	AGA8 Gross, reference temperature for molar density changed
66	AGA8 Gross, reference temperature for relative density changed
67	AGA8 Gross, reference pressure for molar density changed
68	AGA8 Gross, reference pressure for relative density changed
69	AGA9, average velocity changed
70	AGA9, low-flow velocity threshold changed
71	AGA9, enable CPSM (0=off, 1=on) changed
72	AGA9, enable CTSM (0=off, 1=on) changed
73	AGA9, enable profile correction factor (0=off, 1=on) changed
74	AGA9, CPSM state (Calculated=1, Manual=2) changed
75	AGA9, CTSM state (Calculated=1, Manual=2) changed
76	AGA9, profile correction factor state (Calculated=1, Manual=2) changed
77	AGA9, pipe outside diameter changed
78	AGA9, pipe inside diameter changed
79	AGA9, Poisson's ratio changed
80	AGA9, Young's modulus of elasticity changed
81	AGA9, reference pressure changed
82	AGA9, reference temperature changed
83	AGA9, pipe linear expansion coefficient due to temperature changed
84	AGA9, wall roughness changed
85	AGA9, path factor (0.94=Juniorsonic, 1.00=Seniorsonic) changed
86	AGA9, dynamic viscosity changed
87	AGA9, manual CPSM entry changed
88	AGA9, manual CTSM entry changed
89	AGA9, manual profile correction factor entry changed
90	GPA2172, base temperature for density changed
91	GPA2172, base temperature for heating value changed
92	Put static pressure in debug mode (enable=1,disable=2) changed
93	Put differential pressure in debug mode (enable=1,disable=2) changed
94	Put flow temperature in debug mode (enable=1,disable=2) changed
95	Mock static pressure changed
96	Mock differential pressure changed

97	Mock flow temperature changed
98	Static pressure calibration value, high high changed
99	Static pressure calibration value, high changed
100	Static pressure calibration value, low changed
101	Static pressure calibration value, low low changed
102	Differential pressure calibration value, high high changed
103	Differential pressure calibration value, high changed
104	Differential pressure calibration value, low changed
105	Differential pressure calibration value, low low changed
106	Flow temperature calibration value, high high changed
107	Flow temperature calibration value, high changed
108	Flow temperature calibration value, low changed
109	Flow temperature calibration value, low low changed
110	Upstream static pressure changed
111	Differential pressure changed
112	Flow temperature changed
113	AGA7, total pulses changed
2000	Ethernet cable disconnected
2001	Ethernet cable was reconnected
2002	Controller powered up
2003	Modbus slave connection was lost or disconnected
2004	Modbus slave connection established

D. APPENDIX – REPORT AND EVENT COLUMN DEFINIATION

- **Daily report**
  The following are the title header for Daily report.

  ```
  Correction Flag,Time Stamp,Meter Name,Total Flow,Total Flow
  (Corrected),Total Flow Time,Avg SP,Avg DP,Avg FTemp
  ```

- **Monthly report**
  The following are the title header for Monthly report.

  ```
  Correction Flag,Time Stamp,Meter Name,Total Flow Last Month,Total
  Flow Last Month (Corrected),Total Flow Time
  ```

- **Meter report**
  The following are the title header for Meter report.

  ```
  Time Stamp,Meter Name,Inst Flowrate,Inst SP,Inst DP,Inst Flow
  Temp,SG,Comp at Base,Comp at Flow,Contract Hour,Atmospheric
  Press,Base Press,Base Temp,Meter Dia, Orifice Dia,Static Tap
  Location,Orifice Material,Pipe Material,SP Hi Hi,SP Hi,SP Lo,SP
  Lo Lo,DP Hi Hi,DP Hi,DP Lo,DP Lo Lo,FTemp Hi Hi,FTemp Hi,FTemp
  Lo,FTemp Lo Lo,DP Cutoff,Correction Factor,Cd,Y1,Ev
  ```

- **Event log**
  The Event log does not have a header but the section below outlines what each column of data represents.

  ```
  <Unix time>,<old value>,<new value>,<event code>,<username>
  ```

  Where

<Unix time>	Seconds since 1st Jan 2970
<old value>	Value before change
<new value>	Value after change
<event code>	Event log code. Detail of each event code can be found in Appendix C Event Log Code
<username>	Username who made the change. If the user name is “SYSTEM”, it means that the event is performed by the controller. This applies to events such as controller power cycle.